GE Medical Systems

Technical Publications

Direction 14409
Revision 4

Cardiovascular Phantom

Product

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Operating Documentation

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Direction 14409

Revision 4

Cardiovascular Phantom

IMPORTANT!... X-RAY PROTECTION

X-ray equipment if not properly used may cause injury. Accordingly, the instructions herein contained should be thoroughly read and understood before you attempt to place this equipment in operation. The General Electric Company, Medical Systems Group, will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus incorporates a high degree of protection against x-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator to take adequate precautions to prevent the possibility of any persons carelessly, unwisely, or unknowingly exposing themselves or others to radiation.

It is important that everyone having anything to do with x-radiation be properly trained and fully acquainted with the recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports available from NCRP Publications, 7910 Woodmont Avenue, Room 1016, Bethesda, Maryland 20814, and of the International Commission on Radiation Protection, and take adequate steps to insure protection against injury.

All persons authorized to use the equipment must be cognizant of the danger of excessive exposure to x-radiation and the equipment is sold with the understanding that the General Electric Company, Medical Systems Group, its agents, and representatives have no responsibility for injury or damage which may result from exposure to x-radiation.

Various protective material and devices are available. It is urged that such materials or devices be used.

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INTRODUCTION

Purpose

The purpose of this direction is to familiarize the user with the theory and use of the Cardiovascular Phantom. Experience with the phantom since its introduction in 1970 has led to a number of significant refinements in its design and application.

The Cardiovascular Phantom is a required test tool for image performance evaluation of a fluoroscopic system.

Also covered are items which are relevant to the use of the Cardiovascular Phantom, such as filtration, radiation meters, and resolution measuring devices.

This direction addresses the basic concepts behind the various applications of the Cardiovascular Phantom, and will enable the user to understand the reasons for slight variations in procedures with different equipment.

This direction, however, is not intended as a substitute for information contained in the service manuals. The service manuals contain very specific information which relates to the physical constraints and other characteristics of the equipment, and must be referred to in order to obtain proper results.

REVISION HISTORY

REV	DATE	REASON FOR CHANGE
C	June 29, 1984	This was the last of three revisions (A thru C) using the old revision control system.
4	July 31, 1987	Rewrite direction to update procedures and to add 8 inch Cardiovascular Phantom.

LIST OF EFFECTIVE PAGES

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SECTION 1 – THE CARDIOVASCULAR PHANTOM

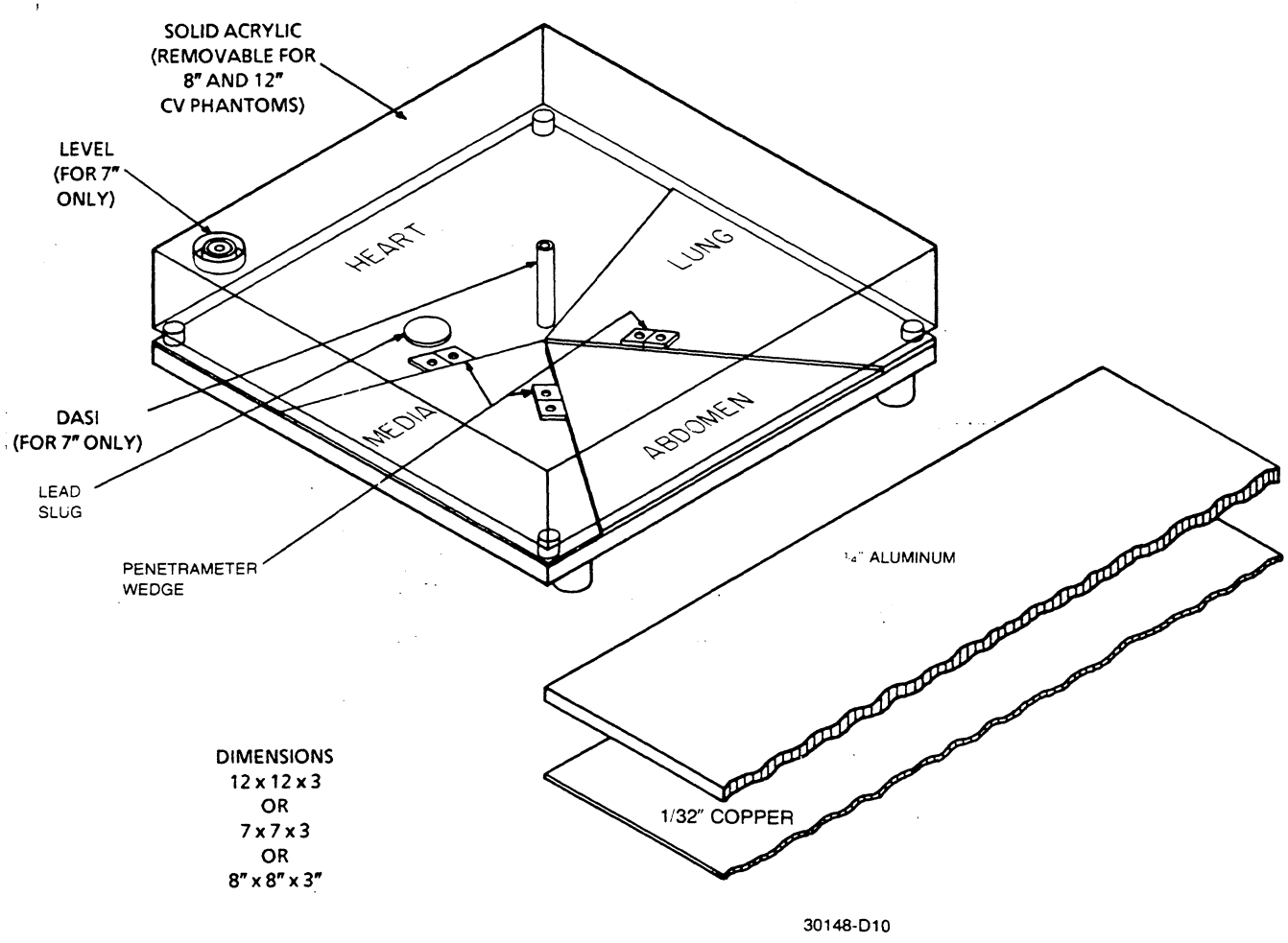


ILLUSTRATION 1-1
CARDIOVASCULAR PHANTOM
7 inch (no longer manufactured), **8 inch, and 12 inch**

Description of CV Phantom

The cardiovascular phantom is designed to represent tissue densities encountered in heart examinations. It consists of four triangular sections made of copper and aluminum with a removable (for 8″ and 12″ phantoms) acrylic block. The relative opacities of these areas are comparable to those of the abdomen, heart, lungs and mediastinum of an adult patient.*

Because radiation absorption is different through metal than through patient anatomy, a fixed kVp must be used to maintain the tissue equivalence of the phantom. This fixed level is 80 kVp.

The cardiovascular phantom can be assembled in three different configurations described in Table 1-1.

Relative transmission of the CV II Phantom at 80 kVp is shown in Table 1-2.

To use the phantom, the acrylic block **MUST** be positioned toward the image receptor. The purpose of the acrylic is to produce the scatter radiation that is normally seen in diagnostic imaging. This scatter does not contribute to the overall radiographic image unless the phantom is positioned properly.

The additional filtration (i.e. copper and aluminum) **MUST** be placed between the X-ray tube and the CV phantom. (Placing the added filtration between the phantom and image receptor would reduce the amount of scatter from the acrylic that reaches the image receptor.)

Accessories

Accessory items in the cardiovascular phantom kits are listed in Table 1-3.

*Refer to Glossary of Medical Terms in Appendix G of this Direction.

TABLE 1-1
CARDIOVASCULAR PHANTOM

ITEM	FUNCTION
1. CV I (Type 1) Cardiovascular Phantom consisting of:	Simulates a 180 lb. patient in the anterior position or a smaller patient in the oblique position at 80 kVp.
(a) Acrylic top (2.25") Note: The acrylic, which is removeable for 8" and 12" phantoms, *MUST* always be included when using the CV phantom.	Simulates X-ray scatter of water and fatty body tissue common to all areas.
(b) Aluminum base (0.250")	Simulates X-ray absorption common to all areas. (See Table 1-2.)
(1) Heart area (0.032" Cu)	Simulates heart X-ray absorption.
(2) Lung area (0.270" Al)	Simulates lung X-ray absorption.
(3) Abdomen area (0.102" Cu)	Simulates abdomen X-ray absorption.
(4) Mediastinum area (0.062" Cu)	Simulates mediastinum X-ray absorption.
2. CV II (Type 2) Cardiovascular Phantom consisting of item 1 (including the acrylic), plus:	Simulates a 180 lb. patient in oblique position or a smaller patient in the lateral position at 80 kVp.
(a) One Filter Sheet (0.250" Al)	Provides additional X-ray absorption to simulate heavier body section.
3. CV III (Type 3) Cardiovascular Phantom consisting of item 1 (including the acrylic), and item 2, plus:	Simulates a 180 lb. patient in the lateral position at 80 kVp.
(a) Another Filter Sheet (0.032" Cu)	Provides additional X-ray absorption to simulate heaviest body section.
4. Items common to all phantoms:	
(a) Circular lead slug	Provides whitest area on exposed film representing base plus fog density, secondary radiation contribution, and internal image tube scatter. This is used during film density calibration procedure.
(b) Lead numbers	Placed on the phantom, characters identify each of several test films by camera lens F-stop setting for comparison of film densities.

TABLE 1-1 (Continued)

(c) Penetrameter wedges	Provides a subjective measure of quantum noise, which decreases as X-ray photons increase. Visualization of small and large holes on CV II (Type 2) phantom confirms system's ability to reproduce 5% and 10% subject contrast. If the image intensifier electronics and cine camera lens are properly calibrated and focused, the holes in the heart section and mediastinum section wedges should be visible due to the darkness of the lung field. No wedge is provided in the abdomen section because of the minimal film density of this area. Normally, the heart section wedge is used to judge quantum noise during a given exposure. The larger of the two holes in the wedge should be visible on all film frames. The smaller hole can be seen during projection of the film as the eye integrates the noise. When a single frame of film is viewed, the smaller hole may not be discernible even though the noise level is not excessive.
(d) Additional Filter Sheet(s) (0.032" Cu)	Each phantom has one or more 0.032" copper filter sheets to facilitate dose rate set up when using a homogeneous filter.

TABLE 1-2
RELATIVE TRANSMISSION OF CV II PHANTOM AT 80 kVp

PHANTOM AREA	RELATIVE TRANSMISSION
HEART	100%
LUNG	227%
ABDOMEN	6%
MEDIASTINUM	30%

TABLE 1-3
ACCESSORIES

The 8 Inch Phantom kit includes the following accessories:

a. DASI Assembly, 46-193456G1 (Refer to Dir. 14410)
b. Copper Mesh Pattern, 60 to 150 Wires per Inch, 46-187635P1
c. Copper Mesh Pattern, 16 to 60 Wires per Inch, 46-187636P1
d. Optical Comparator, 10 x Magnifier, 46-262700P1
e. 0.0125" x 8" x 8" Aluminum Sheet, 46-262699P1
f. 5 lp/mm Resolution Pattern, 46-197871P2
g. Copper Step Wedge, 46-262703P1
h. Low Contrast Phantom, Consisting of the Following:
   - 0.5 mm Copper, 46-262704P1
   - 0.5 mm Aluminum, 46-262704P2
   - 1.0 mm Aluminum, 46-262704P3
   - 2.0 mm Aluminum, 46-262704P4
i. Star Pattern, 46-193546P1
j. Vinyl Film Holder, 10" by 12", 46-262710P1
k. 0.1" x 5" x 6.44" Aluminum Absorber, 46-173632G1
l. X-Ray Output Diode Timer, 46-194427P82
m. 20 Foot Cable, 46-194427P83
n. 40 x 40 Mesh Screen Plaque, 46-162166G4

The 12 Inch Phantom kit includes the following accessories:

a. 5" x 5" Aluminum Filter, 46-162048G1
b. 12 x 12 Mesh Screen Plaque, 46-162166G1
c. 20 x 20 Mesh Screen Plaque, 46-162166G2
d. 30 x 30 Mesh Screen Plaque, 46-162166G3
e. 40 x 40 Mesh Screen Plaque, 46-162166G4
f. 5 lp/mm Resolution Pattern, 46-197871P2 (Formerly the kit included, instead, a 2.5 lp/mm Resolution Pattern, 46-162456P1)

The 7 Inch Phantom kit (no longer manufactured) **includes the following accessories:**

a. DASI Assembly, 46-193456G1 (Refer to Dir. 14410)
b. Copper Mesh Pattern, 60 to 150 Wires per Inch, 46-187635P1
c. Copper Mesh Pattern, 16 to 60 Wires per Inch, 46-187636P1
d. Optical Comparator, 7 x Magnifier, 46-197870P1
e. 4.8 lp/mm Resolution Pattern, 46-197871P1

SECTION 2 - DOSE RATE MEASUREMENT

2-1 DOSE RATE, GENERAL

Phantom Thickness and Operating Level

Dose rates are measured with a homogenous phantom. In order to be consistent, we must insure that the image receptor (i.e. the image tube) receives the same energy radiation every time that the dose rates are measured or adjusted. Different absorption materials affect the energy level of the x-ray photons. Therefore, we must hold not only the operating kVp constant, but also keep the filtration constant.

Copper has the greatest effect on the energy spectrum, aluminum has a much smaller effect, and acrylic has the least effect of all.

All Fluoro dose measurements should be made with at least 1/32" copper and 1/4" aluminum in the beam. Acrylic from the CV phantom is also used in order to drive up the mA. The 8" and 12" phantoms are designed for easy removal of the acrylic scatter block for this purpose.

Rules

Fluoro: During Fluoro dose rate measurement, the phantom thickness must be enough to provide at least 0.2 mA. This ensures that the mA meter reading errors are minimal. Increase filtration as required to obtain this minimum mA value.

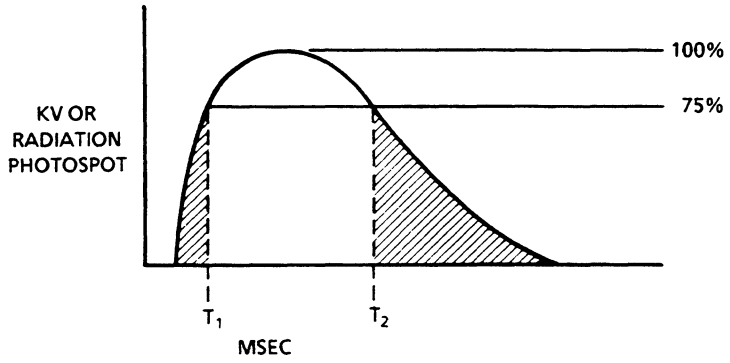
Cine: For cine applications, avoid pulse widths below 2.0 msec when measuring dose rates. Do this by using the small focal spot. The no load kVp immediately prior to a cine pulse is considerably higher than the selected operating kVp. When the cine pulse begins, the kVp drops to the selected value due to the high loading on the power supply. The value of 2 msec has been chosen to ensure that the transition period from high kVp to selected kVp does not have a significant effect on the average kVp during the pulse.

Remember that at kVp's other than 80, the tissue equivalence of the Cardiovascular Phantom changes.

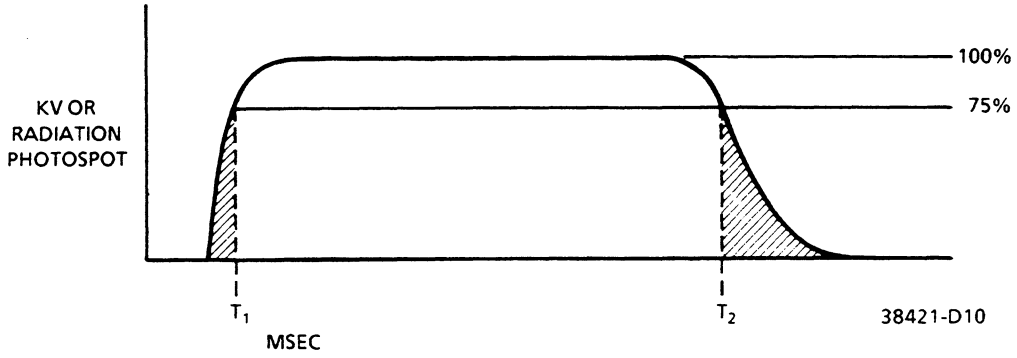
Photospot: When measuring dose rates in Photospot, ensure that the exposure is greater than 15 msec., and that the kVp waveform (or radiation waveform as observed with a radiation sensitive diode) does not have an excessive decay time. High kVp and/or low mA techniques results in longer decay times, as compared to lower kVp or higher mA techniques. Longer exposures obtained by increasing filtration also help minimize effects of decay time. An excessive decay time adds radiation (and film density) over and above that called for by the brightness control circuits.

The effect on patient films of a system that has been adjusted using exposures with excessive decay times is usually that thin anatomy is properly exposed, and heavier anatomy is under exposed.

Usually, the service manuals specify appropriate technic factors for set up. However, due to variations in intensifiers and x-ray tubes, the suggested technics may not always provide satisfactory exposures as defined above. For optimum results, always be sure of the kVp or radiation waveform (See Illustration 2-1.)



(a) Tail contributes excessively to exposure, causing unwanted film density. Shaded area under curve is greater than 20% of total area under curve.



(b) Tail does not add excessively to the exposure. Shaded area under curve is less than 20% of total area under curve.

ILLUSTRATION 2-1

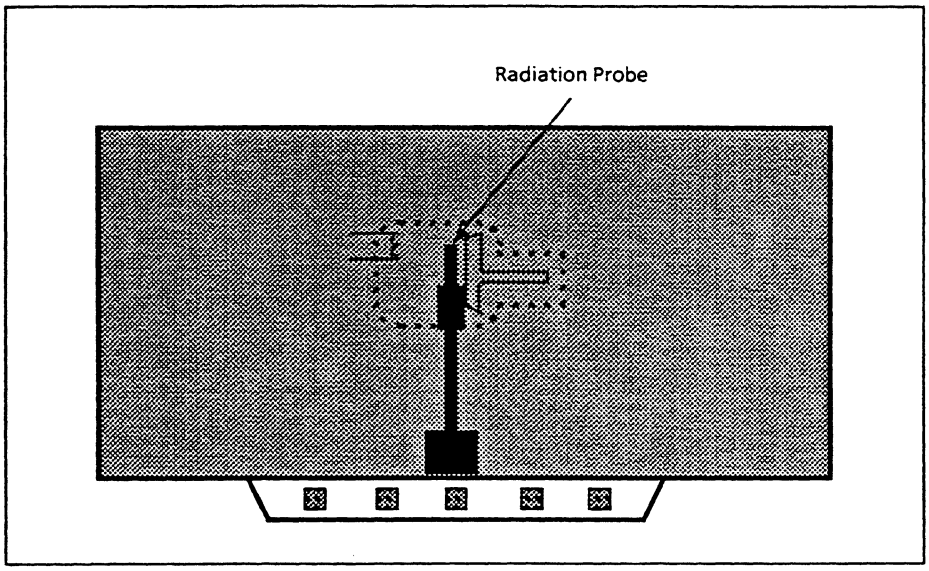
Radiation Probe Orientation

Radiation probe orientation for dose rate measurements or set ups must be such that the long axis of the probe is oriented perpendicular to the x-ray tube anode-cathode axis.

For LU systems, the direction of the anode-cathode axis is parallel to the axis of symmetry of the x-ray tube unit.

For R&F systems, the anode-cathode axis is parallel to the length of the table. In an R&F system with an undertable x-ray tube, the tube is hidden from view. For this case, refer to Illustration 2-2 to visualize the orientation of the probe.

ILLUSTRATION 2-2
RADIATION PROBE ORIENTATION FOR R&F WITH UNDERTABLE X-RAY TUBE



Entrance Plane The entrance plane of the image intensifier is referenced in procedures for dose rate measurement. Refer to Illustration 2-3 for the definition of the location of the entrance plane.

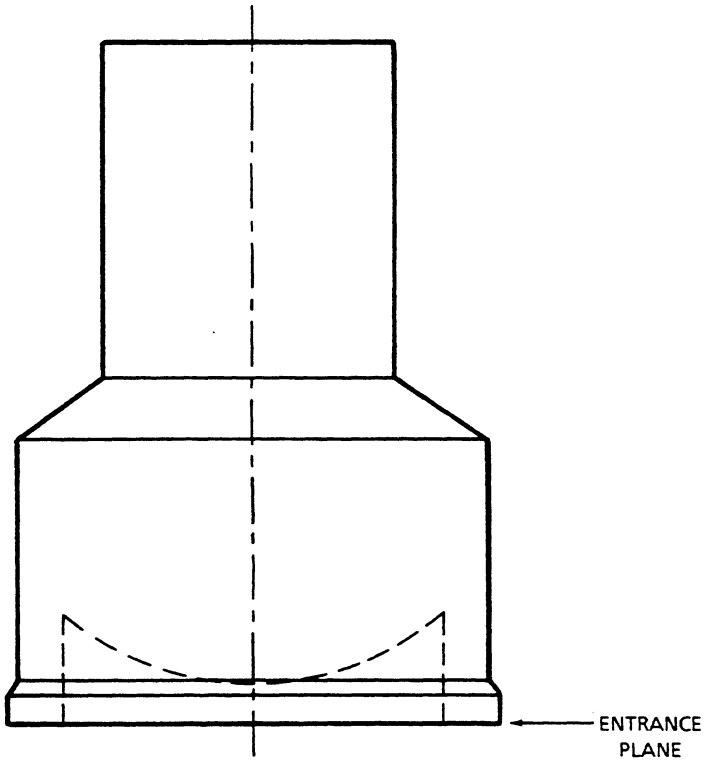


ILLUSTRATION 2-3
ENTRANCE PLANE OF IMAGE INTENSIFIER

2-2 FLUORO AND EXCL VTR INPUT DOSE

Description

The purpose of this procedure is to measure the amount of radiation required to satisfy the Automatic Brightness control circuits.

(If readjustment of dose rate is required, refer to the appropriate image intensifier product service manual for the set up procedure.)

Specification

The input dose is measured at the maximum field size. For three dose systems:

Dose 1	1.8 mR/min	.108 R/hr
Dose 2	3.6 mR/min	.216 R/hr
Dose 3	7.2 mR/min	.432 R/hr
Ex VTR	14.4 mR/min	.864 R/hr

For single dose 6" system dose is set to 5.4 mR/min (.324 R/hr).

Tools and Test Equipment Required

- 1/32" Cu & 1/4" Al
- 2.25" Acrylic from the CV phantom
- DC mA meter
- "R" meter

Procedure

1. Establish the following conditions:
   - 80 kVp
   - Select small focal spot
   - ABC operating.
   - Remove grid.

Conventional Systems

- II at minimum SID.

LU systems

- Place II 12" (30 cm) above the table top with table top at isocenter. (x-ray tube at maximum SID).
- Normal FOV.
- Collimator blades fully open.
- Position 1/32" Cu, 1/4" Al, and the acrylic from the CV phantom in the x-ray beam.
- kVp override on.

Note: If kVp rises above 80, remove acrylic from field of view.

- Monitor x-ray tube mA with DC mA meter installed at HV Xformer.

2. For each dose and for exclusive VTR, in normal mode, measure x-ray mA according to the DC milliammeter installed in the HV transformer.

Note: Use the mA scales that provide the most accurate readings.

3. Record the milliampere readings.

Conventional Systems 4. Measure the height of II above the table top at minimum SID.

Systems with 88, 85, 8835,or 8535 SFD
- Measure to center of the bottom of the SFD entrance window.

Systems with 89 PED
- Measure to center of the bottom of pedestal.

5. Move II to maximum SID.

6. Position center line of probe at a distance above the table top as follows.

Systems with 88, 85, 8835, or 8535 SFD
- Add 4-1/2" (116 mm) to height measured in preceding steps. Set probe to a height above the table top equal to this sum.

Systems with 89 PED
- Add 1-3/8" (35 mm) to height measured in preceding steps. Set probe to a height above the table top equal to this sum.

LU-C/LU-A
- Set the probe height equal to 12" (30 cm) above the table top.

7. Orient long axis of probe perpendicular to anode-cathode axis. (If this is a R&F system with undertable x-ray tube, see Illustration 2-2.)

8. Operate system in **manual mode** to reproduce each of the mA's recorded.

Note: Use the mA scales that provide the most accurate readings.

Note: In the L-series image systems, a jumper must be moved to get into manual mode for Exclusive VTR.

9. For each mA, measure and record the exposure rate.

2-3 PHOTOSPOT INPUT DOSE

Description

The purpose of this procedure is to measure the amount of radiation entering the image intensifier during photospot filming.

(If readjustment of dose rate is required, refer to the appropriate image intensifier product service manual for the set up procedure.)

Specification

The nominal photospot input dose is 100 µR/frame for largest field size. Setting input dose is a compromise between radiation exposure and noise in the image. The input dose may be lowered if image quality is satisfactory to the physician.

Tools and Test Equipment Required

- (3) 1/32" Cu
- 2.25" Acrylic from the CV phantom
- "R" meter

Procedure

1. Establish the following conditions:
   - 80 kVp
   - Disable kVp override
   - Normal mode
   - Remove grid.
   - Disable photospot camera to inhibit running.
   - (3) 1/32" Cu and acrylic from the CV phantom placed in the x-ray beam.
   - Collimator blades fully open.
   - Select Photospot mode
   - Select Series
2. Make Trial exposures and select mA and/or adjust SID distance to obtain an exposure time of between 40-80 msec. (Do not select mA's below 50.)
3. Make exposure and press photospot exposure hold at the same time. If system has SFD with no hold function record exposure time, kV, and mA.
4. Measure the distance from the table top to the entrance plane of the image tube for LU systems, or the bottom of the spot film device for R&F systems. (For definition of entrance plane, see Illustration 2-3.)
5. Raise the image tube to maximum SID.

6. Position center line of probe at a distance above the table top as follows.

Systems with 88, 85, 8835, or 8535 SFD
- Add 4-1/2" (116 mm) to height measured in preceding steps. Set probe to a height above the table top equal to this sum.

Systems with 89 PED
- Add 1-3/8" (35 mm) to height measured in preceding steps. Set probe to a height above the table top equal to this sum.

LU-C/LU-A
- Set the probe height equal to the height measured in Step 4.

7. Insure "R" meter probe is totally visible as viewed on the monitor.

8. Orient long axis of probe perpendicular to anode-cathode axis. (If this is a R&F system with undertable x-ray tube, see Illustration 2-2.)

9. Select:
   - 1 frame per second
   - 10 second film run
   - "Total" mode on "R" meter

   If system has SFD with no hold function:
   - Select spot-film mode
   - No AEC
   - kVp the same as photospot exposure
   - mA the same as photospot exposure
   - Select exposure approximately ten times photospot exposure
   - Remove film from SFD
   - Total mode on "R" meter

10. Press the photospot record foot switch and hold until the complete sequence has stopped. If system has SFD with no hold function, take spot-film exposure.

11. Divide the total amount of radiation by the number of exposures taken (10) and record this on the photospot data sheet. If system has SFD with no hold function, multiply the total amount of radiation by the photospot exposure time divided by the spot-film exposure time.

12. Install grid.

13. Set camera switch to the run position.

2-4 CINE INPUT DOSE

Description

The purpose of this procedure is to measure the radiation available during cine filming. The selection of a cine dose level is a compromise between maintaining a low noise level on film, minimizing radiation to the patient and operators and minimizing heat loading on the x-ray tube unit.

(If readjustment of dose rate is required, refer to the appropriate image intensifier product service manual for the set up procedure.)

Specification

The nominal cine input dose is 30 µR/frame in the 6" mode. Setting input dose is a compromise between radiation exposure and noise in the image. The input dose may be lowered if the image quality is satisfactory to the physician.

Tools and Test Equipment Required

- CV II phantom
- "R" meter

Procedure

1. Establish the following conditions:
   - 80 kVp
   - Remove grid
   - ABC in auto mode
   - Small focal spot
   - 6" FOV (This is the most common cine mode of operation).
   - 30 frames/sec
   - PW limit to max.
   - Disable cine camera to inhibit film transport.
2. Place the heart section of the CV II phantom into the x-ray beam.
3. Collimator blades fully open.
4. Confirm that the table top is at isocenter.
5. Position image tube 12" (30 cm) above table top.

LU-A Systems

5a. Position the x-ray tube to minimum SID.

6. Depress cine record foot sw and allow system to stabilize (green band). Activate Cine Hold sw and stop exposure.

Note: If unable to attain greenband, select large focal spot.

7. Raise II high enough to eliminate back scatter while keeping the full volume of the probe in the x-ray field.

8. Position center line of probe at 12" (30 cm) above table top.

9. Orient the long axis of the probe perpendicular to the anode cathode axis.

10. Depress the cine record foot switch and record the exposure rate.

11. The exposure per frame equals the exposure rate (R/sec) divided by 30 (frames per sec).

SECTION 3 - CINE/PHOTOSPOT SENSITOMETRIC DATA

Description

Film characteristics are important factors in determining the contrast and dynamic range of the system. The system gain is also influenced by film sensitivity and film processing. This procedure explains how to acquire the sensitometric data and calculate the average gradient of the film.

Tools and Test Equipment Required

- Green light sensitometer
- Densitometer
- Film processor

Procedure

1. Expose a test strip of film using a green light sensitometer. Place emulsion side to the light source.
2. Use a densitometer to measure the density of the steps on the test strip. Place emulsion side of film to the sensor.
3. Graph density versus step on grid system found on a blank Film Sensitometric Data Sheet. (See Illustration 3-1.) This is the sensitometric curve commonly called the H&D curve. Recording all 21 steps provides a more accurate plotting of the sensitometric curve.
4. Following the example below, calculate the average gradient of the film and record on the data form.

   - We define the following quantities:

     "D" max = 1.5+ base fog density

     "D" min = 0.25+ base fog density

   - Example:

     a. Assume base fog density = 0.1 then,

        "D" max = 1.6

        "D" min = 0.35

     b. Locate the density of "D" max on the sensitometric curve, and read the log relative exposure corresponding to this point.

     c. Repeat last step for "D" min.

     d. Compute the average gradient using the formula:

        Avg G = ("D" max - "D" min) / (log rel exp ["D" max] - log rel exp ["D" min])

        By definition "D" max - "D" min - = 1.25

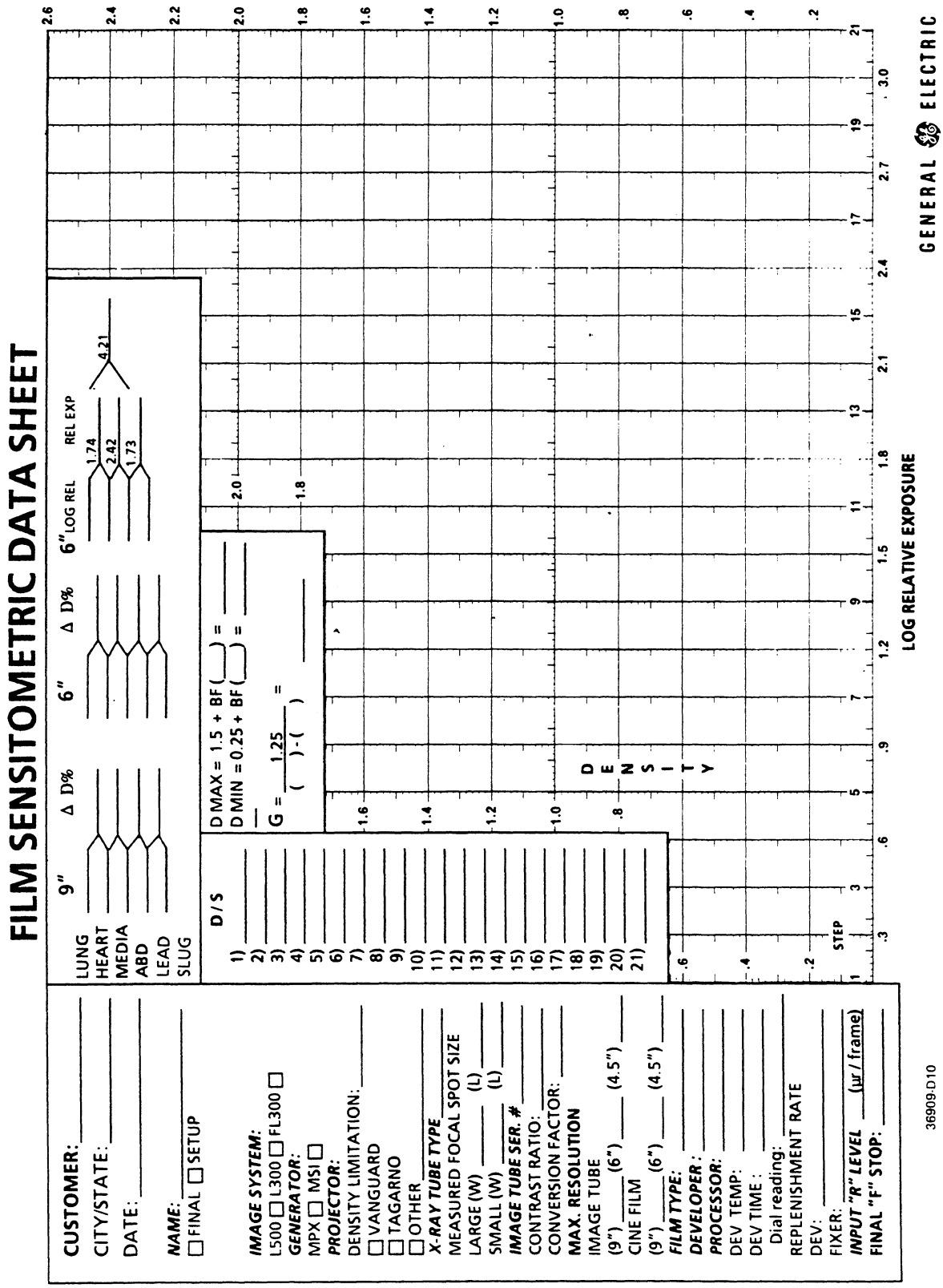


ILLUSTRATION 3-1

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SECTION 4 - CINE PROJECTOR DENSITY LIMIT

Description

The density obtained on film should not be greater than the maximum density the projector can penetrate. This procedure determines the maximum amount of penetration.

Tools and Test Equipment Required

- CV II Phantom
- Densitometer
- Film processor

Specification

The cine projector must be able to visualize 5% contrast objects in the lung.

Procedure

1. Establish the following conditions:
   - Cine ABC to manual
   - Center CV II phantom in the field of view
   - 80 KVP
   - 6" FOV
   - Table top to isocenter
   - Image intensifier 12" above table top
   - 60 frames/sec frame rate
2. Start exposing the cine film with the manual pulse width pot to minimum. Slowly increase the pulse width to maximum during the cine run.
3. Projector measurement:
   - Run the film made from the above test on the projector to be tested.
   - Find the frame in which the 5% contrast area (small penetrameter) in the lung section of the phantom just becomes visible.
   - Remove the film from the projector. Measure and record the density of the lung area of that frame.

SECTION 5 - CINE FILM DENSITY

Description

This procedure tests the contrast and dynamic range of the system during cine filming by using the CV II phantom.

Specifications

1. Cine Film Density:

   The cine film density should be between 0.8 and 1.1, (dependent on the projector used), in the heart section of the CV II phantom in the 6 inch field of view at 80 kVp.

2. Cine Lens Aperture Size:

   The cine lens aperture is adjusted to produce desired film density in the heart section of the CV II phantom in the 6 inch field of view at 80 kVp. It is recommended that the aperture be small enough so that the f stop is above 2.4.

   f stop = focal length/diameter of aperture

Tools and Test Equipment Required

- Calculator capable of doing logarithms
- CV II Phantom
- Densitometer
- Film processor
- Sensitometer

Procedure

1. Film processor should be stabilized. Perform the sensitometry on the cine film as described in Section 3 of this Direction.

2. Establish the following conditions:
   - Center CV II phantom in the field of view
   - Grid in
   - 80 KVP
   - LU Systems - Table top at isocenter. II 12" above isocenter.
   - 30 frames/sec
   - Large focal spot
   - ABC in auto mode
   - Collimator full open (limited to field size)

3. Expose two runs of cine using both 6" and 9" FOV.

4. Measure the densities of all segments of the CV II phantom and record on the Film Sensitometric Data Sheet (Illustration 3-1).

   Measure densities as close to the apexes as possible. See Illustration 5-1. (However, for the 7" phantom, stay away from the lead beads.)

   See Illustration 5-2 for a typical example of a Film Sensitometric Data Sheet filled in for cine.

5. Using the example below, calculate the delta D%, percent density change, between the different segments of the CV II phantom and record this on the Film Sensitometric Data Sheet (Illustration 3-1).

   Example: Use formula delta D5 = ((D2-D1)/D1)X100

   Assume Lung density = D2 = 1.65
   Heart density = D1 = 1.09

   Then delta D% = ((1.65-1.09)/1.09)X100 = 51.37

6. Calculate and record the relative exposure values.

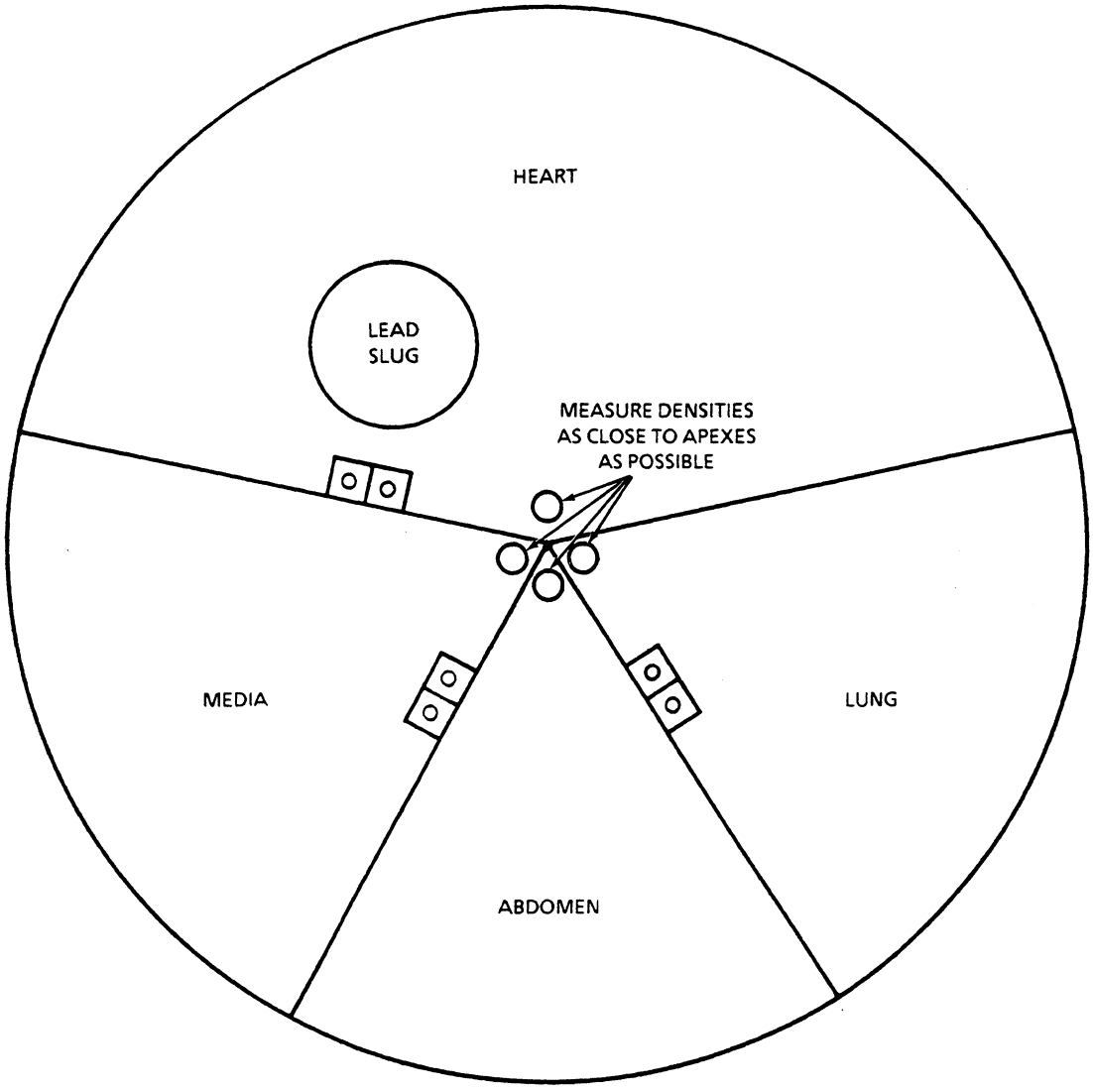
   - Read the log relative exposure from the grid system on the Film Sentiometric Data sheet (Illustration 3-1).
   - Record these values on the Film Sentiometric Data sheet.
   - Using the example below, compute the difference in log relative exposure between neighboring segments of the CV II phantom. Record the relative exposures on the Film Sentiometric Data sheet.

     Example:

     Assume for Lung; log rel exp = 2.52
     Heart; log rel exp = 2.29

     Difference log rel exp = 2.52 – 2.29 = 0.23

     Then relative exposure between heart and lung = antilog 0.23 = 1.7.



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All density measurements should be made with a 2 mm or smaller aperture. Read film emulsion side up.
Measure densities as close to apexes as possible. (However, for the 7" phantom, stay away from the lead beads.)

ILLUSTRATION 5-1

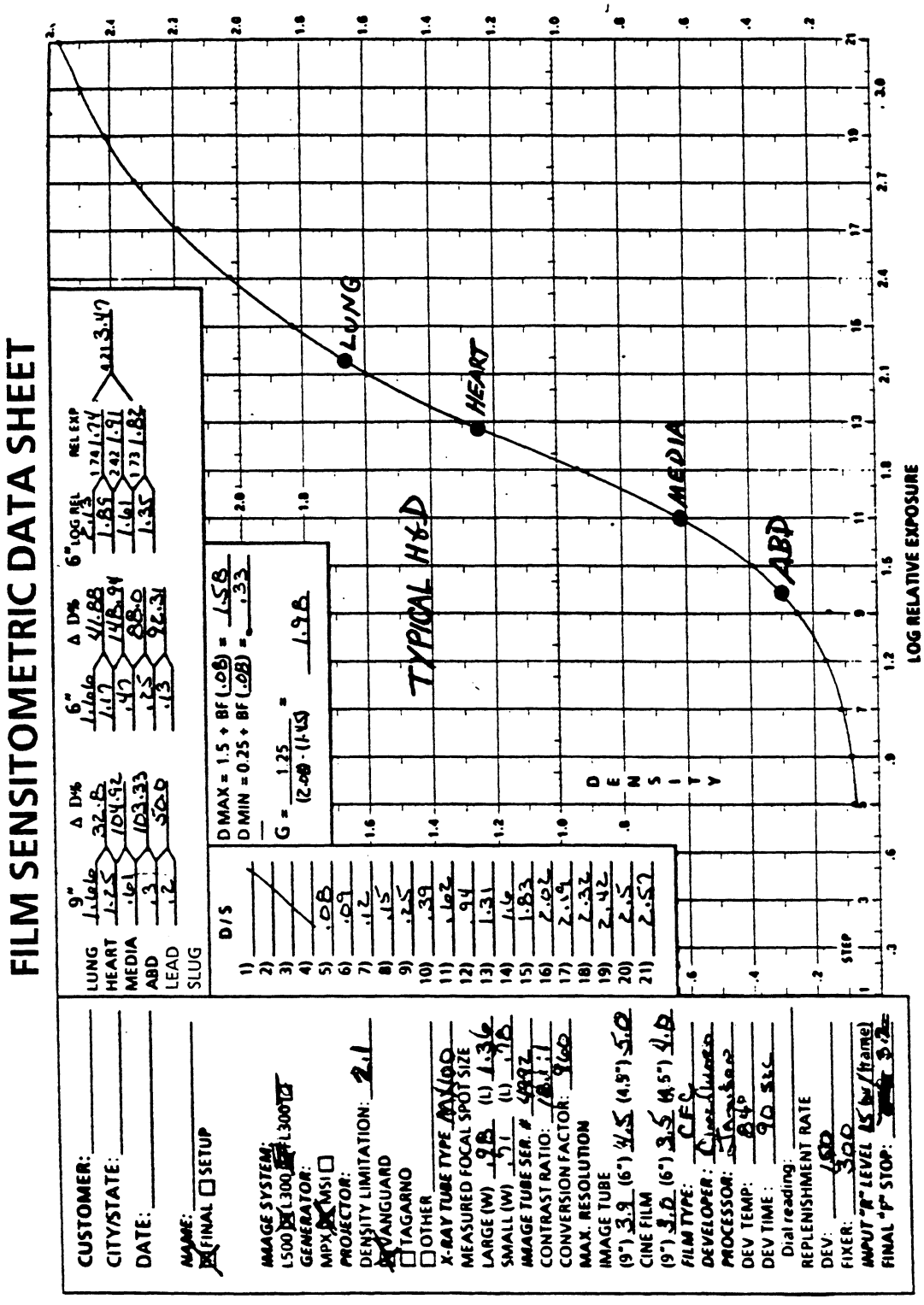

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ILLUSTRATION 5-2
SENSITOMETRIC DATA SHEET SAMPLE FILLED IN FOR CINE

SECTION 6 – PHOTOSPOT FILM DENSITY

Description

This procedure tests the contrast and dynamic range of the system during photospot filming by using the CV II phantom.

Specifications

Photospot Film Density:

The heart density in the CV II phantom should be between 1.4 and 1.5 at normal field of view at 80 kVp.

Tools and Test Equipment Required

- CV II phantom
- Densitometer
- Film processor
- Sensitometer

Procedure

1. Film processor should be stabilized. Perform the sensitometry on the photospot film as described in Section 3 of this Direction.
2. Establish the following operating conditions:
   - Center CV II phantom in FOV
   - Grid in
   - 80 kVp
   - Single exposure
   - 200-400 mA large focal spot
   - Normal FOV
   - **LU systems:**
     - Table top at isocenter. II 12" above isocenter
   - **R&F systems:** Min SID
3. Expose and develop 2 films.

4. Measure the densities of all segments of the CV II phantom and record on the Film Sensitometric Data Sheet (Illustration 3-1).

   Measure densities as close to the apexes as possible. See Illustration 6-1. (However, for the 7" phantom, stay away from the lead beads.)

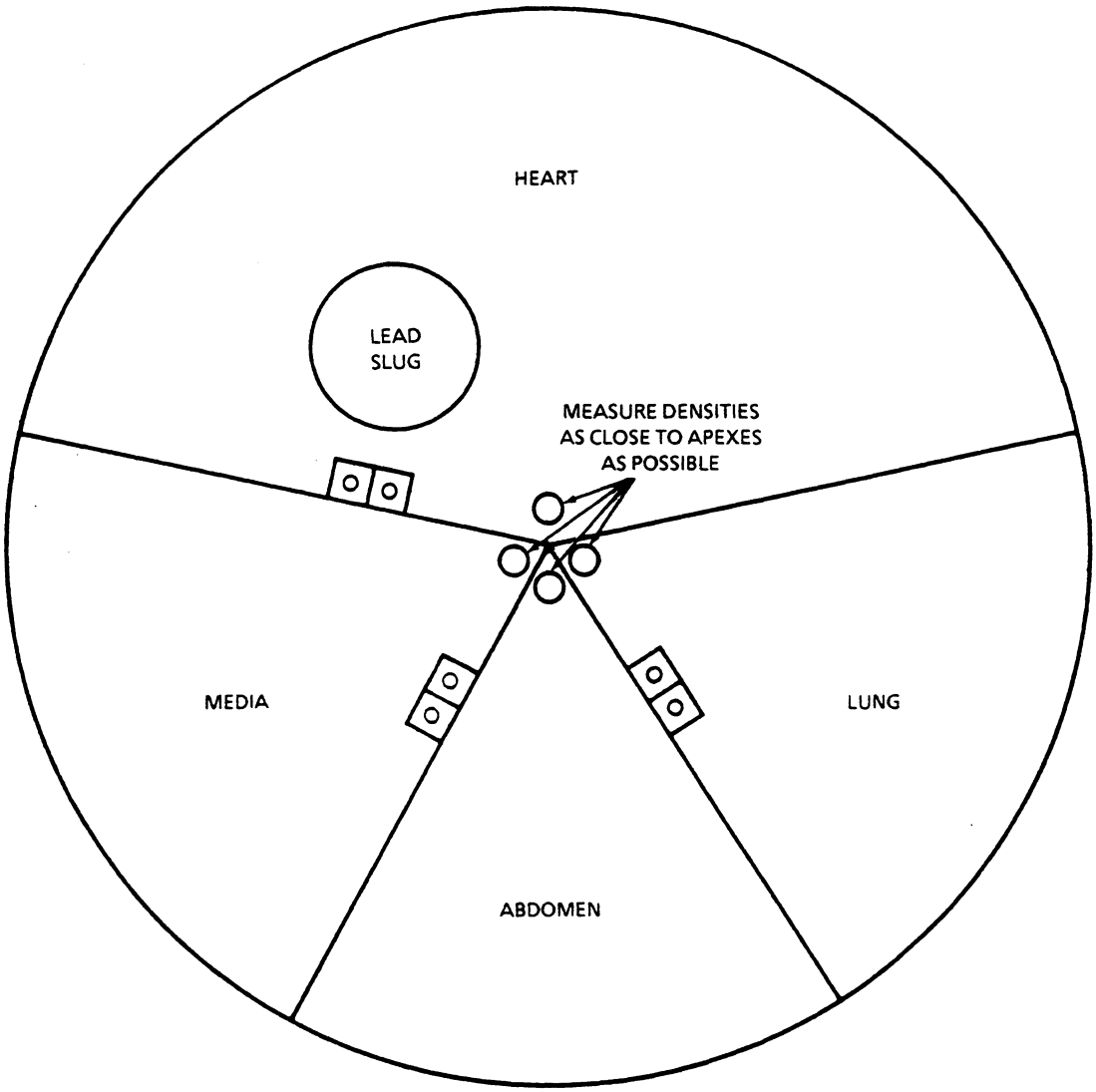
5. Using the example below, calculate the delta D%, percent density change, between the different segments of the CV II phantom and record this on the Film Sensitometric Data Sheet.

   Example: Use formula delta D% = ((D2-D1)/D1)x100

   Assume Lung density = D2 = 1.65
   Heart density = D1 = 1.09

   Difference log rel exp = 2.52-2.29 = 0.23

   Then relative exposure between heart and lung = antilog 0.23 = 1.7



30151-D11

All density measurements should be made with a 2 mm or smaller aperture. Read film emulsion side up.
Measure densities as close to apexes as possible. (However, for the 7" phantom, stay away from the lead beads.)

ILLUSTRATION 6-1

SECTION 7 - RESOLUTION

7-1 RESOLUTION, GENERAL

Resolution Measurement Devices:

Resolution Wedge: The procedures on the following pages for measuring resolution for fluoro, VTR, and cine, all specify a 5 lp/mm resolution wedge. Also, one of the two alternative methods for measuring photospot resolution specifies the 5 lp/mm resolution wedge.

The 8 inch phantom kit is furnished with a 5 lp/mm resolution pattern, 46-197871P2.

The 12 inch phantom kit is now furnished with a 5 lp/mm resolution pattern, 46-197871P2. (The 12 inch phantom kit formerly was furnished, instead, with a 2.5 lp/mm resolution wedge, 46-162456P1. The 2.5 lp/mm wedge may give higher readings because of the greater lead content.)

The 7 inch phantom kit (no longer manufactured) includes a 4.8 lp/mm resolution pattern, 46-197871P1.

Copper Meshes: The other alternative method for measuring photospot resolution specifies the following two copper mesh patterns:

- 60 to 150 wires per inch copper mesh, 46-187635P1
- 16 to 60 wires per inch copper mesh, 46-187636P1

These two copper mesh patterns are furnished with the 7" and the 8" phantoms.

7-2 FLUORO RESOLUTION

Description This procedure describes how to measure the fluoro limiting resolution.

Specification TV minimum horizontal resolution (lp/mm).

System	FOV	RESOLUTION (lp/mm)		
		525/625		1023/1249
		Sb_2S_3	PbO	Primicon Czicon
9"	9	1.4	1.2	1.7
	6	1.8	1.6	2.2
	4	2.5	2.3	2.6
12"	12	1.2	1.0	1.3
	9	1.6	1.5	1.7
	6	2.0	1.9	2.1

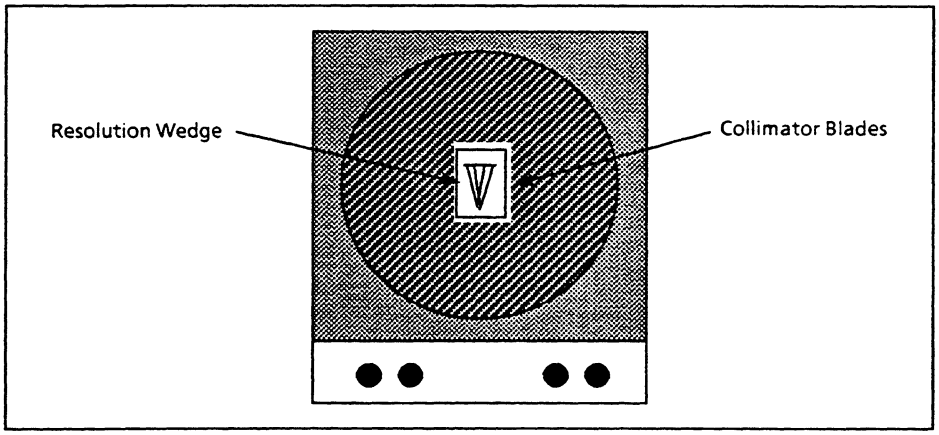
Tools and Test Equipment Required Resolution wedge (5 lp/mm, 0.1 mm Pb)

Procedure

1. Establish the following operating conditions
   - 60 kVp
   - KV override disabled.
   - Maximum SID.
   - No grid (unless grid non-removable).
   - 1/4" Aluminum
   - Dose 2 for multiple dose system.

2. Placement of Pattern

ILLUSTRATION 7-1
RESOLUTION PATTERN PLACEMENT



- Place the 5 lp/mm resolution pattern (0.1 mm Pb) as close to the entrance plane as possible with longer axis of pattern perpendicular to the raster lines.
- If grid non-removable place pattern 45°.
- Collimate to the resolution pattern. Image on monitor should look like Illustration 7-1.

Note: In some systems the automatic brightness control may cause the image to bloom if the collimator blades are coned down too much. Open the collimator blades so that blooming does not occur.

- Mark customer's monitor brightness and contrast settings.
- Remove glare. This can most easily be done by turning off room lights.
- Set monitor brightness and contrast to maximize reading resolution limit as defined as point on pattern at which at least 5 lines can be counted.

3. Read resolution in all three mag modes and record.
4. If system has VTR, record wedge image **during fluoro** for measuring resolution of VTR playback. (See Section 7-3.)
5. Return brightness and contrast to customer settings.

7-3 VTR RESOLUTION

Description

This procedure measures the resolution of the recorded image during playback.

Specification

The VTR resolution is determined by its bandwidth, and the effect of VTR resolution on system resolution depends on the line rate and field size of the system.

The 525 line rate system and the 1023 line rate system have 52.4 µsec and 25.6 µsec visible line times respectively. The table below gives the resolution that can be accommodated by the VTR per megahertz of bandwidth at the different field sizes.

RESOLUTION/1 MHZ OF BANDWIDTH

Mode	Field Size (mm)	525 (lp/mm)	1023 (lp/mm)
4.5"	115	0.46	0.22
6"	152	0.34	0.17
9"	210	0.25	0.12
12"	270	0.19	0.09

Tools and Test Equipment Required

- Resolution Wedge (5 lp/mm, 0.1 mm Pb)
- 1/4" Al

Procedure

1. While measuring resolution in fluoro mode (See Sec. 7-2), a video tape recording should be made. The resolution is measured on the played back image.

2. Compute the bandwidth of the VTR by dividing the limiting resolution of the playback image by the appropriate entry in the table above.

7-4 PHOTOSPOT RESOLUTION

Description

This procedure is used to determine the limiting resolution of photospot.

Use either of the two alternative test methods that are given:

- Copper mesh method
  (The copper mesh patterns are furnished with the 7″ and the 8″ phantoms.)
- Resolution wedge method

Specification

Photospot resolution is measured with mesh, or with a resolution wedge, and must meet the requirements specified in the tables below.

9″ SYSTEM

Field Size	Center to 50% Radius (Mesh)	50% Radius (Mesh)	Resolution Wedge lp/mm
9″	50	40	2.5
6″	60	50	3.0
4.5″	80	70	4.0

12″ SYSTEM

Field Size	Center to 50% Radius (Mesh)	50% Radius (Mesh)	Resolution Wedge lp/mm
12″	50	40	2.5
9″	60	50	3.0
6″	70	60	3.5

At 60 kVp, 1 lp/mm on a wedge resolution pattern = 21 mesh. This is an approximation.

Method #1 - Mesh Method

Tools and Test Equipment Required

- Film processor
- 1/4" Al
- 60 to 150 Wires per Inch Copper Mesh (46-187635P1)
- 16 to 60 Wires per Inch Copper Mesh (46-187636P1)

Procedure

1. Establish the following operating conditions:
   - Insert 1/4" Al phantom
   - Remove grid(s)
   - 60 kVp
   - Maximum SID
   - Small focal spot
   - Normal FOV
   - Single exp.
   - Select an mA on the x-ray generator to produce an exposure above 2 msec.
2. Record 1-2 frames of film in each field size.
3. In normal FOV, place the 60 to 150 lines per inch copper mesh pattern as close to the entrance plane as possible. (For definition of entrance plane, see Illustration 2-3.)
4. Select an mA on the generator to produce an exposure of about 2 msec.
5. Make an exposure on film for each of the field sizes.
6. Replace the mesh pattern with the 16 to 60 lines per inch copper mesh pattern.
7. Make an exposure on film for each of the field sizes.
8. Develop the film and determine maximum resolution. Read mesh resolution separately for the center and the edge. The center consists of a circle of 50% radius.

Method #2 - Resolution Wedge Method

Tools and Test Equipment Required

- Film processor
- 1/4" Al
- Resolution Wedge (5 lp/mm, 0.1 mm Pb)
- 10x magnifier

Procedure

1. Establish the following operating conditions:
   - Insert 1/4" Al phantom
   - Remove grid(s)
   - 60 kVp
   - Maximum SID
   - Small focal spot
   - Normal FOV
   - Position the 5 lp/mm pattern (0.1 mm Pb) as close to the entrance plane as possible.
   - Collimate to the resolution wedge.
   - Single exposure
   - Select an mA on the x-ray generator to produce an exposure above 2 msec.
   - Film density must be between 0.5 and 0.8 in the lead background of the wedge.
2. Record 1-2 frames of film in each field size.
3. Read with a 10x magnifier the maximum resolution defined as the most extreme point on the pattern at which at least 5 lines can be counted.

7-5 CINE RESOLUTION

Description This procedure describes how to measure cine limiting resolution.

Specification The limiting cine resolution must exceed the value in the tables below.

9" SYSTEM

	9"	6"	4"
Min Spec (lp/mm)	2.3	2.6	3.2

12" SYSTEM

	12"	9"	6"
Min Spec (lp/mm)	1.4	2.0	2.2

Tools and Test Equipment Required

- Resolution Wedge (5 lp/mm, 0.1 mm lead)
- 1/4" Al

Procedure

1. Establish the following operating conditions:
   - Remove the grid(s)
   - Manual fluoro mode
   - 1/4" Al in FOV
   - Small focal spot
   - Select 60 kVp fluoro & cine
   - Select 30 frame rate
   - Position the 5 lp/mm (0.1 mm lead) resolution wedge as close to the II tube input phosphor as possible and center it vertically
   - Install the focaligner on the cine port of the image gate.
   - Select the image mirror to rotate to the cine port.

2. Press the fluoro foot sw and view the image through the focaligner.

3. Collimate to the size of the wedge.

4. Record the maximum resolution seen in the NORM, MAG 1 & MAG 2 modes.

5. Remove the focaligner and install the cine camera.

6. Reset the fluoro ABC to auto.

7. Deselect the image gate mirror.

8. Press the cine record foot sw and record a short strip of cine film in each of the mag modes. (Ensure that the system is "green banding").

9. Process the film.

10. Select a frame from each of the 3 modes and record the maximum resolution.

SECTION 8 - FLUORO STEP WEDGE RESPONSE

(Copper Step Wedge Furnished with 8" CV Phantom)

Description

The number of steps viewed on the oscilloscope trace is a measure of the dynamic range of the system.

Specification

For systems without P/C, the video voltage of the base of the test pattern should be between 900 mV and 1100 mV above blanking. For systems with P/C, the video voltage should be between 600 mV and 800 mV.

At least 5 distinct steps should be visible on the video waveform. The dynamic range of the video system may be estimated using the table below.

# of Distinct Steps	Brightness Relative to Base	Dynamic Range
1	0.48	2
2	0.25	4
3	0.15	7
4	0.09	11
5	0.05	20
6	0.03	33
7	0.02	50

Tools and Test Equipment Required

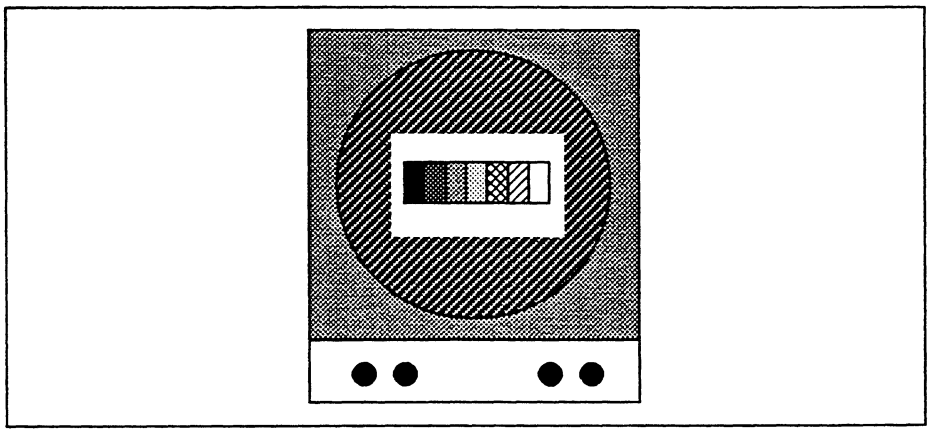
- Cu step wedge, 46-262703P1
- 1/4" Al
- 1/32" Cu
- Oscilloscope
- Optional camera (Polaroid)

Procedure

1. Step Wedge Response
   - Establish the following operating conditions:
     - 90 kVp.
     - Grid in.
     - 6" mode.
     - Dose 2.
     - Disable KV override.
     - Collimator blades open.
2. Video signal level.

   With 1/4" Al and 1/32" copper in x-ray beam and ABC in, record video processor output above blanking for a single raster line near the center of the image. Video processor output (above blanking) =
3. If scope camera is available, take a picture of the video processor output.
4. Placement of step wedge.
   - Place copper step wedge on top of 1/4" Al and 1/32" copper.
   - Step edges should be perpendicular to raster lines. Thickest step of wedge should be at left of image (see Illustration 8-1).
   - Adjust SID so that all of wedge and some surrounding base are visible.

ILLUSTRATION 8-1
IMAGE OF WEDGE ON MONITOR



5. Measurement
   - Go into manual mA mode.
   - View a single line of video processor output as previously described.
   - **Peak sensing systems:**

     Adjust mA so that peak signal is at the video processor output level just measured.
   - **Average sensing systems:**

     Adjust mA so that the second step of the copper wedge is at the video processor output level just measured.
   - Read voltages above blanking across steps and record.

6. If scope camera is available, take a picture of the video waveform of the step wedge. (See Illustration 8-2 for the step wedge response.)

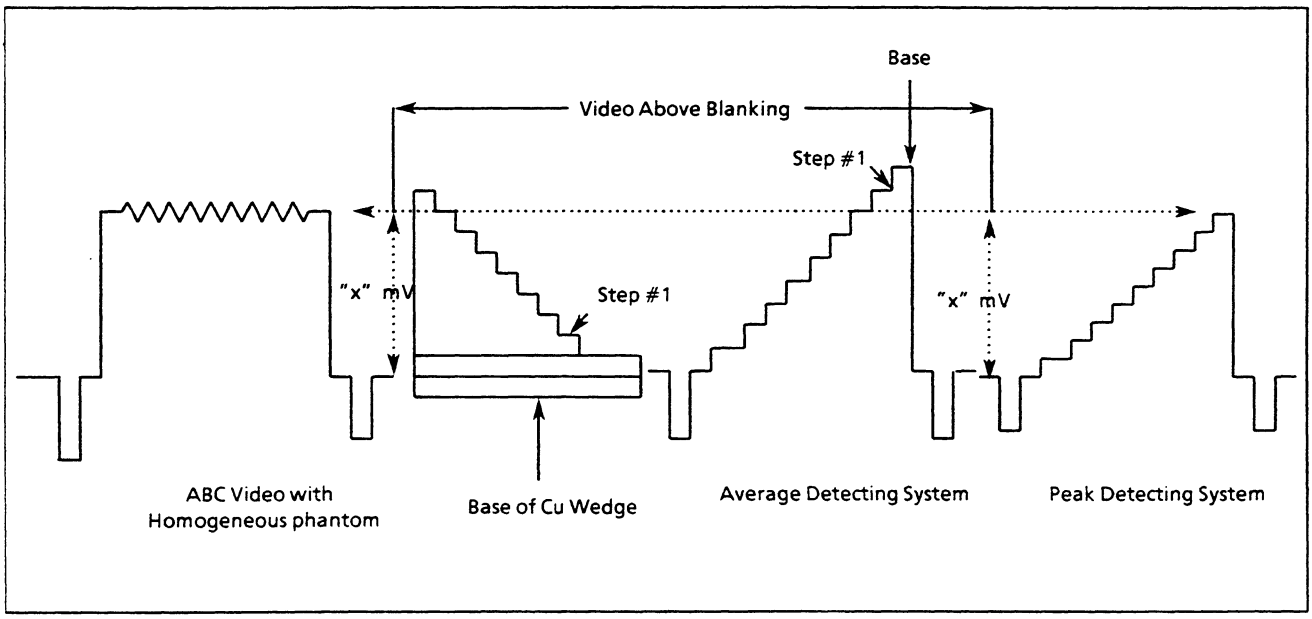


ILLUSTRATION 8-2
STEP WEDGE RESPONSE

SECTION 9 – LOW CONTRAST PHANTOM TESTS

(Low Contrast Phantom Furnished with 8" CV Phantom)

9-1 FLUORO CONTRAST DETAIL

Description The measurement of contrast detail detectability is closely related to the detection of low contract objects in clinical practice.

Specification The minimum number of visible holes are given in the tables below.

LFOV

		.5 mm Cu	2 mm A1	1 mm A1	.5 mm A1
9"	R&F	6	4	4	2
	DF	6	5	4	3
6"	R&F	6	4	4	2
	DF	6	5	4	3

REGULAR

		.5 mm Cu	2 mm A1	1 mm A1	.5mm A1
9"	R&F	6	4	3	1
	DF	6	4	3	0
	VHR	6	4	3	0
6"	R&F	6	4	3	2
	DF	6	5	4	1
	VHR	6	5	3	1

For the same field sizes, dose levels for LFOV are higher than for regular systems.

Tools and Test Equipment Required

- CV II Phantom
- Low contrast phantom
  - 0.5 mm Copper, 46-262704P1
  - 0.5 mm Aluminum, 46-262704P2
  - 1.0 mm Aluminum, 46-262704P3
  - 2.0 mm Aluminum, 46-262704P4

Procedure

1. CV II Phantom:
   - 80 kVp
   - Position table top at isocenter and II, 12" above table for LU systems
   - Minimum SID for R&F
   - Grid in
   - CV II Phantom centered in field of view
   - Dose 2 for L-Series systems
   - Monitor contrast and brightness adjusted for optimum contrast detectability.
   - Verify that all penetrameter holes can be seen in 9" and 6" modes before proceeding to the next step .

2. Low Contrast Phantom:
   - Max SID
   - Grid out
   - 90 kVp
   - 1/4" Al & 1/32" Cu in FOV
   - Fix each test plate as close as possible to the entrance plane

     (See Illustration 2-3 for definition of entrance plane.)
   - Collimate to the edges of test pattern
   - Dose 2
   - Keep monitor and contrast controls the same as setting for the CV II phantom
   - View from a distance that is 4 times the diameter of the viewing circle
   - Room lights off
   - In 9" and 6" modes, read the number of holes visible for the 2 mm Al, 1 mm Al, 0.5 mm Al and 0.5 mm Cu plates
   - Record these numbers.

9-2 CINE LOW CONTRAST DETAIL

Description

This procedure describes how to measure the contrast detectability for the Cine system. The measurement of contrast detail detectability is closely related to the detection of low contrast objects in clinical practice.

Specification

MINIMUM NUMBER OF VISIBLE HOLES

fov	.5 mm Cu	2 mm Al	1 mm Al	.5 mm Al
6"	6	5	3	2

Tools and Test Equipment Required

- (1) 1/4" Al
- (1) 1/32" Cu
- Low contrast phantom
  - 0.5 mm Copper, 46-262704P1
  - 0.5 mm Aluminum, 46-262704P2
  - 1.0 mm Aluminum, 46-262704P3
  - 2.0 mm Aluminum, 46-262704P4

Procedure

1. Establish the following operating conditions:
   - 1/4" A1 & 1/32" Cu in FOV
   - 90 kVp
   - 6" mode
   - Small focal spot
   - Max SID
   - Grid removed
   - Cine ABC in auto mode
   - Low contrast plate taped to input phosphor
2. Make four bursts of cine and record a short strip of film for each of the low contrast plates.
3. Process the film.
4. View the test film on a projector and determine the number of holes visible in the low contrast plate.
5. Record this number.

SECTION 10
RENEWAL PARTS

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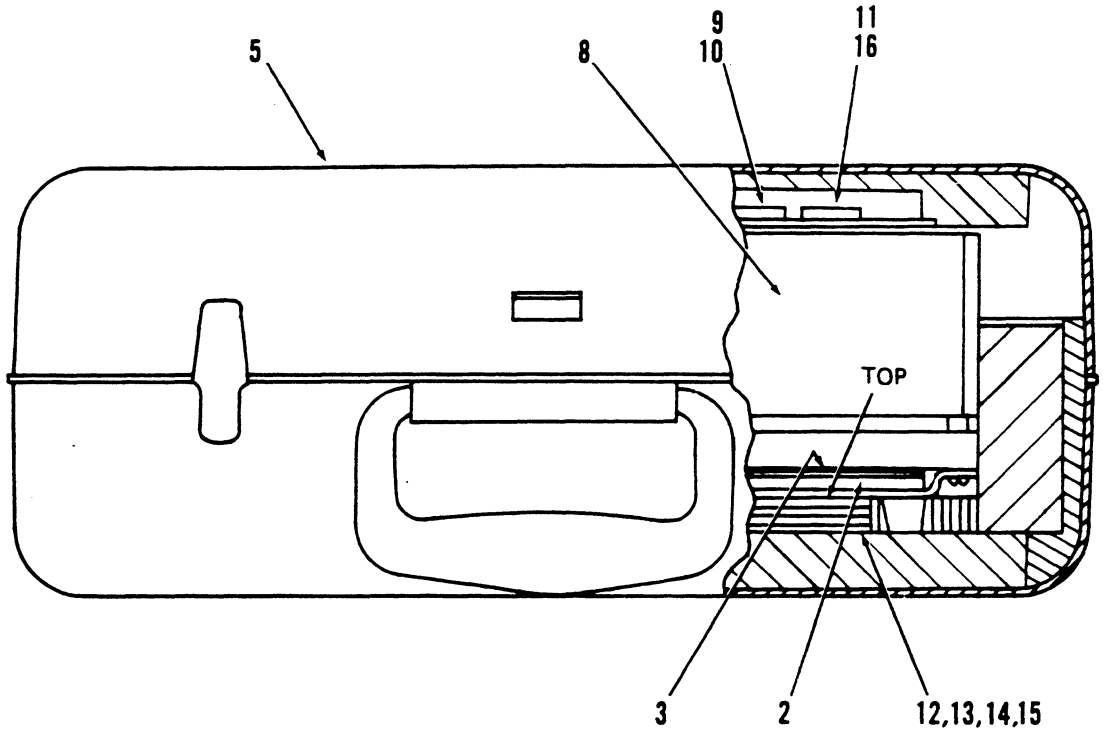
8" PHANTOM KIT, 46-262707G1	10-4
8" PHANTOM, 46-262576G1	10-5

CARDIOVASCULAR 12" PHANTOM KIT, (46-156797G1) E6320AB



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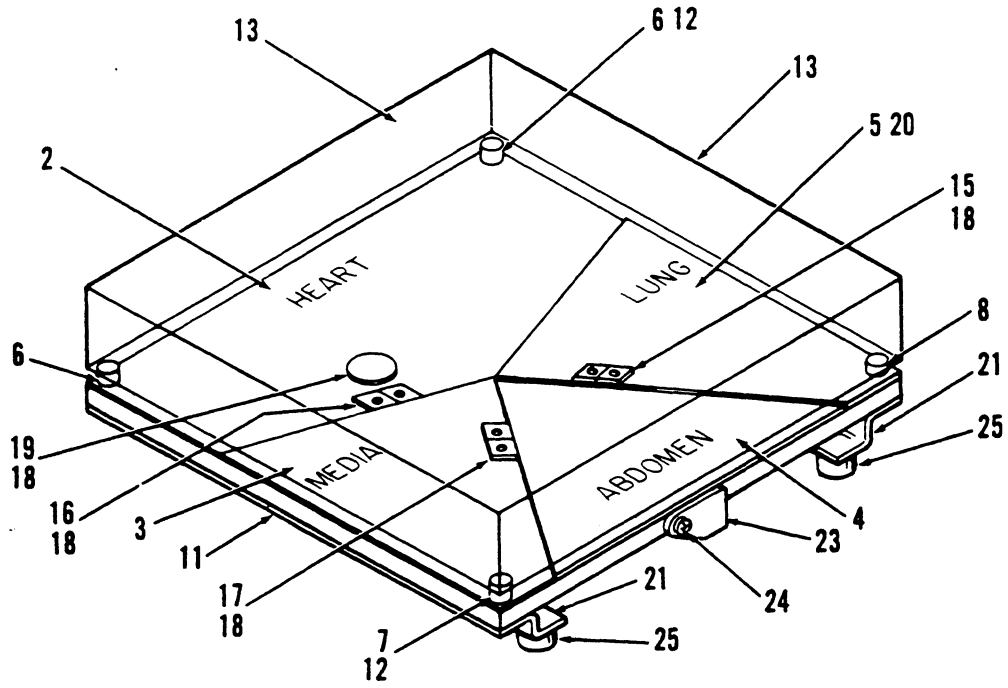
ITEM NO.	NAME	PART NO.	DESCRIPTION
1 (1)	LEAD LETTER KIT	514A281G4	Part of E6320AB
2	FILTER	46-156796P2	Aluminum .250 x 10.24 x 12
3	FILTER	46-156796P1	Copper .032 x 10.24 x 12
5	CASE	46-156700P1	
8	12" PHANTOM	46-156780G1	See Page 10-1
9	BAG	508A865P4	
10	FILTER	46-162048G1	.278 x 5 x 5, Aluminum
11	BAG	508A865P2	
12	SCREEN	46-162166G1	12 x 12 mesh .02 wire
13	SCREEN	46-162166G2	20 x 20 mesh .016 wire
14	SCREEN	46-162166G3	30 x 30 mesh .011 wire
15	SCREEN	46-162166G4	40 x 40 mesh .009 wire
16	PATTERN	46-197871P2	0.5 to 5.0 lp/mm resolution

(1) Not identified in view.

12" PHANTOM, 46-156780G1



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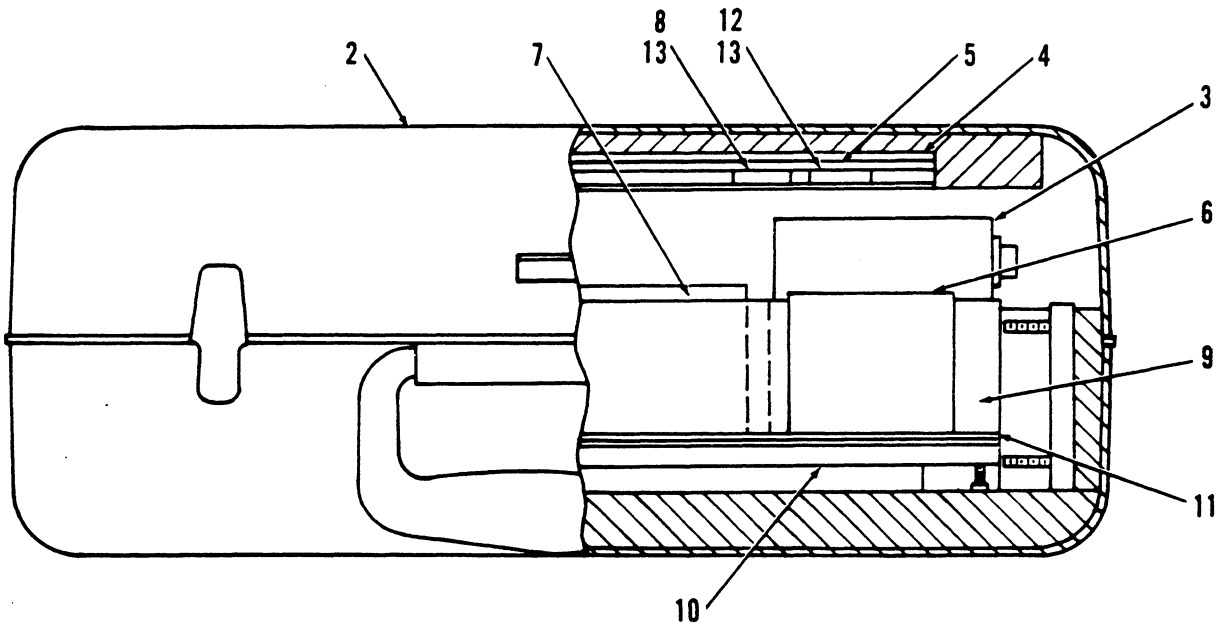
ITEM NO.	NAME	PART NO.	DESCRIPTION
2	HEART WEDGE	46-156777P1	
3	MEDIA WEDGE	46-156778P1	
4	ABDOMEN WEDGE	46-156779P1	
5	LUNG WEDGE	46-156783P2	
6	SPACER	46-156575P1	.50 lg., 2 used
7	SPACER	46-156575P2	.47 lg.
8	SPACER	46-156575P3	.26 lg.
11	BASE PLATE	46-156785P1	.25 thick
12	SCREW	18029	Round head 6-32 UNC x 1-1/2, 4 used
13	BLOCK	46-156784P1	2.25 thick
15	WEDGE	46-156562P1	.040 thick
16	WEDGE	46-156563P1	.076 thick
17	WEDGE	46-156564P1	.094 thick
18	TAPE	46-170107P2	Double stick
19	LEAD SLUG	46-156571P1	.125 thick x 1.0 diameter
20	WEDGE	46-156783P1	Lung, 2 used
21	BRACKET	46-156573P1	2 used
23	RETAINER	46-162033P1	2 used
24	DRIVE SCREW	14182	Round head U4 x 3/16
25	BUMPER	12788	4 used

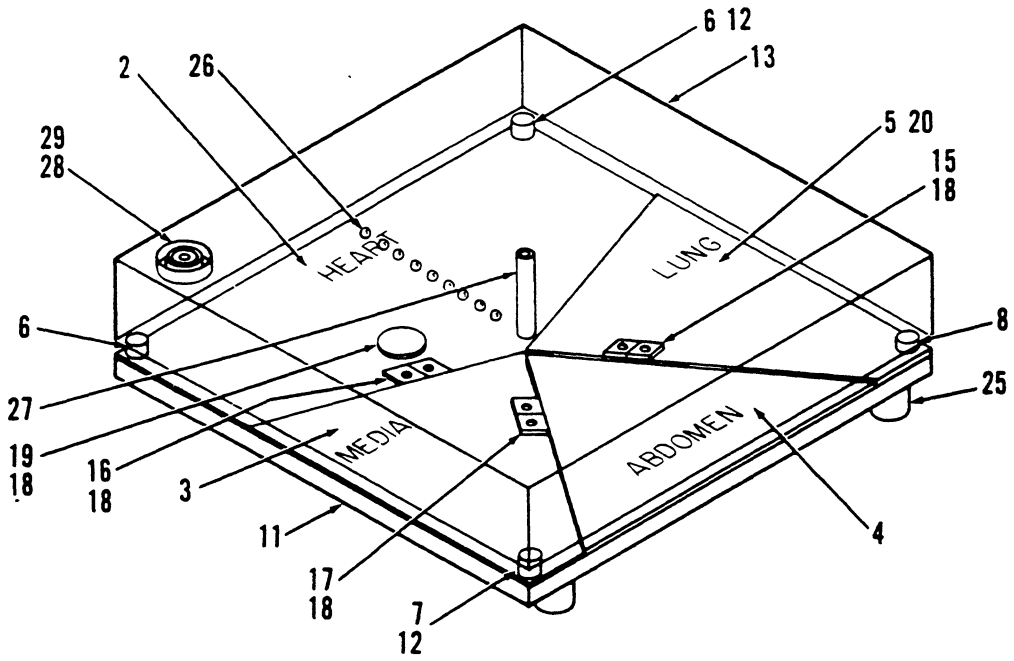
CARDIOVASCULAR 7" PHANTOM KIT, 46-176464G1



31507-D10

ITEM NO.	NAME	PART NO.	DESCRIPTION
2	CASE	46-156700P1	
3	DASI	46-193456G1	Type II
4	SCREEN	46-187636P1	16 to 60 mesh 7" square
5	SCREEN	46-187635P1	60 to 150 mesh 7" square
6	OPTICAL COMPARATOR	46-197870P1	Metric scale, 7X power
7	7" PHANTOM	46-176451G1	See Page 10-3
8	PATTERN	46-197871P1	1.0 to 4.86 lp/mm resolution
9	PADDING	46-176463P1	1.75 thick foam
10A	FILTER ASSEMBLY	46-176470G1	Includes Items 10A, 10B. For L300
10B	CAP SCREW	46-170498P12	Hex socket 10-32 UNF x 1.0, 3 used, Part of Item 10
10C	FILTER	46-184740P1	Aluminum .250 x 10.24 x 12. Part of Item 10
11	FILTER	46-156796P1	Copper .032 x 10.24 x 12, 2 used
12	LEAD LETTER KIT	514A281G4	

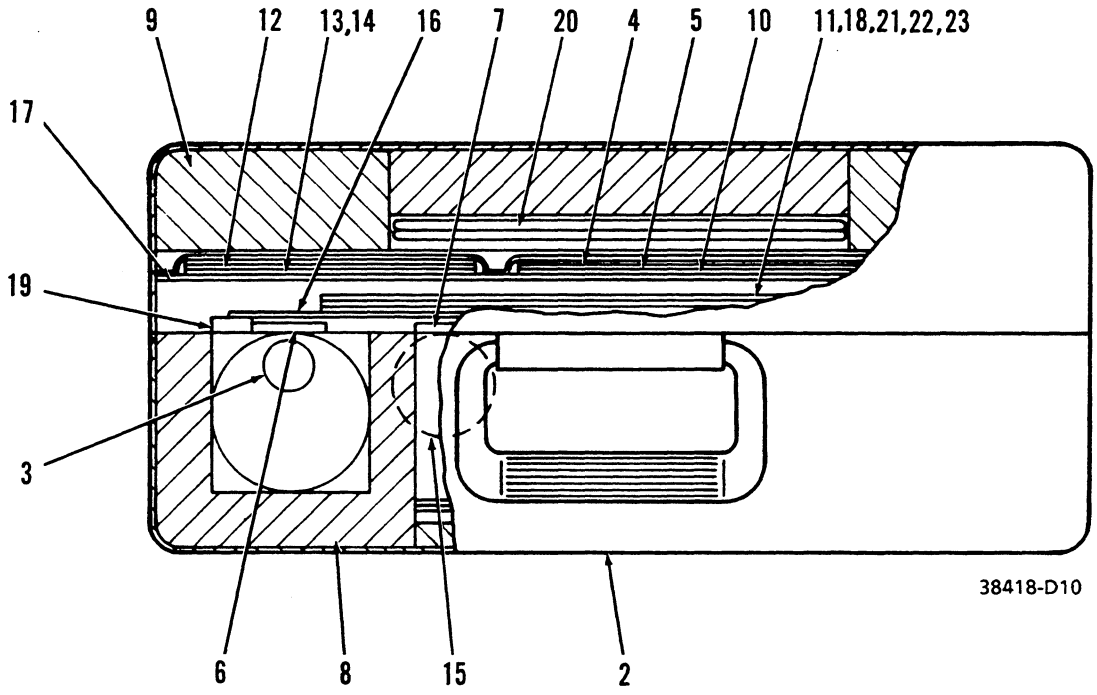
7" PHANTOM, 46-176451G1



30148D12

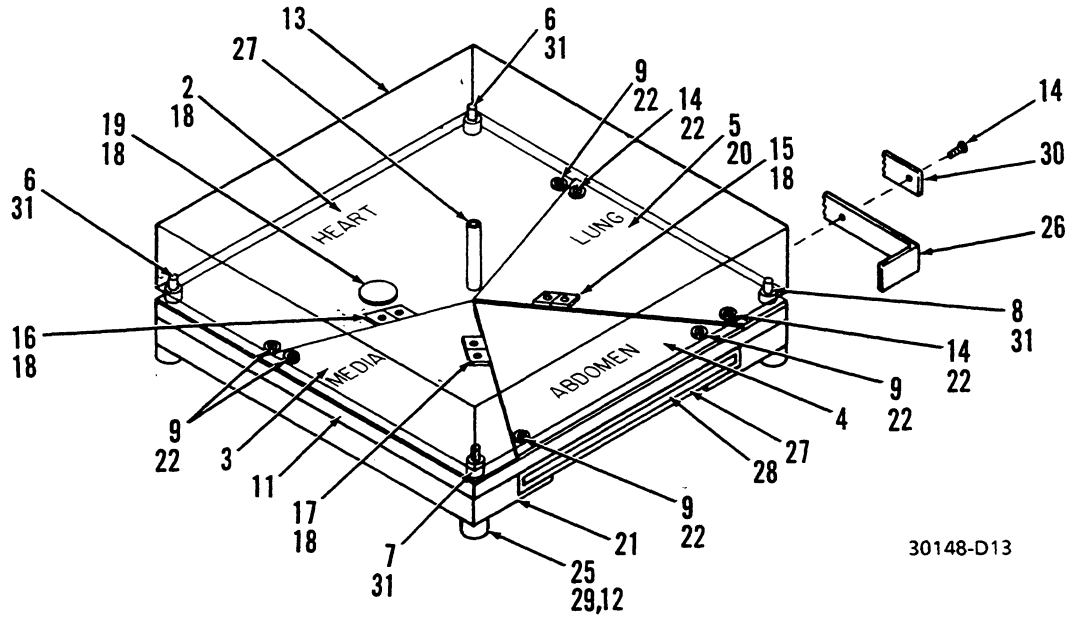
ITEM NO.	NAME	PART NO.	DESCRIPTION
2	HEART WEDGE	46-176457P1	
3	MEDIA WEDGE	46-176455P1	
4	ABDOMEN WEDGE	46-176456P1	
5	LUNG WEDGE	46-176454P2	
6	SPACER	46-156575P1	.50 lg., 2 used
7	SPACER	46-156575P2	.47 lg.
8	SPACER	46-156575P3	.26 lg.
11	BASE PLATE	46-176453P1	
12	SCREW	18029	Round head 6-32 UNC x 1-1/2, 4 used
13	BLOCK	46-176452P1	2.25 thick
15	WEDGE	46-156562P1	.040 thick
16	WEDGE	46-156563P1	.076 thick
17	WEDGE	46-156564P1	.094 thick
18	TAPE	46-170107P2	Double stick
19	LEAD SLUG	46-156571P1	.125 thick x 1.0 diameter
20	WEDGE	46-176454P1	Lung, 2 used
25	BUMPER	18684	4 used
26	BALL	14370	Steel .062 diameter, 36 used
27	TUBE	46-176462P1	
28	LEVEL	46-197810P1	Bubble
29	SEALANT	46-170888P1	Loctite 06, 1 oz.

CARDIOVASCULAR 8" PHANTOM KIT, 46-262707G1



ITEM NO.	NAME	PART NO.	DESCRIPTION
2	CASE	46-216784P1	
3	DASI ASSEMBLY	46-193456G1	Type II
4	PATTERN	46-187636P1	16 to 60 mesh 7" square
5	PATTERN	46-187635P1	60 to 150 mesh 7" square
6	OPTICAL COMPARATOR	46-262700P1	10 X power, 0-20 mm metric scale, with case
7	PHANTOM	46-262576G1	See Page 10-5
8	PADDING	46-262706P1	Bottom
9	PADDING	46-262708P1	Top
10	SHEET	46-262699P1	Aluminum 8" x 8" x .125 thick
11	PATTERN	46-197871P2	0.5 to 5.0 lp/mm resolution
12	PHANTOM WEDGE	46-262703P1	Copper (Performance Test)
13A	TEST PATTERN	46-262704P1	Copper .020 (For low contrast)
13B	TEST PATTERN	46-262704P2	Aluminum .020 thick
13C	TEST PATTERN	46-262704P3	Aluminum .040 thick
13D	TEST PATTERN	46-262704P4	Aluminum .081 thick
14	SCREEN	46-162166G4	40 x 40 mesh .009 wire
15	STAR	46-193546P1	50 micron lead, 2° sector angle 45 mm diameter
16	FILM HOLDER	46-262710P1	10" x 12"
17	PALLET	46-262709P1	
18	X-RAY ABSORBER	46-173632G1	
19	TIMER	46-194427P82	X-Ray output, diode
20	CABLE	46-194427P83	20' long
21	LETTER KIT	514A281G4	

8" PHANTOM, 46-262576G1



ITEM NO.	NAME	PART NO.	DESCRIPTION
2	HEART WEDGE	46-262587P1	
3	MEDIA WEDGE	46-262586P1	
4	ABDOMEN WEDGE	46-262585P1	
5	LUNG WEDGE	46-262584P2	
6	SPACER	46-262583P1	.50 lg., 2 used
7	SPACER	46-262583P2	.47 lg.
8	SPACER	46-262583P3	.26 lg.
9	SCREW	46-208560P68	Bind hd. 6-32 x .25 lg., 5 used
11	BASE PLATE	46-262582P1	1.25
12	SCREW	46-208560P31	Bind hd. 6-32 x 1.25 lg., 4 used
13	BLOCK	46-262581P1	2.25 thick, Acrylic
14	SCREW	46-208560P27	Bind hd. 6-32 x .50 lg., 4 used
15	WEDGE	46-156562P1	.040 thick
16	WEDGE	46-156563P1	.076 thick
17	WEDGE	46-156564P1	.094 thick
18	TAPE	46-170107P2	Double stick
19	LEAD SLUG	46-156571P1	.125 thick x 1.0 diameter
20	WEDGE	46-262584P1	Lung, 2 used. Under Item 5
21	FOOT	46-262577P1	2 used
22	WASHER	17200	.15 ID x .44 OD x .02 THK
25	BUMPER	46-230582P1	4 used
26	RETAINER	46-262579P1	
27	FILTER	46-262580P1	.032 Copper, 3 used
28	FILTER	46-262580P2	.25 Aluminum
29	SEALANT	46-170684P1	Loctite 271 .5 cc
30	BAR	46-262578P1	
31	FASTENER	46-230732P1	Tinnerman C23764-014-3B

APPENDIX A
RADIATION METERS

Here are some notes on the use of radiation meters:

Precision of Readings

Assume that we have set a fluoro dose rate of 3.6 mR/min in the nine inch mode. If the radiation meter reads in mR/min and provides a two-digit display of 3.6, then there is an uncertainty factor to consider in this reading. Specifically, if we allow one least significant digit for noise and one more for meter resolution, then the uncertainty in the reading is 2 digits out of 36, or slightly less than 6%. This error is independent of meter accuracy. Therefore, if a person was using a meter with ± 5% accuracy, it is conceivable that he could obtain a reading as much as 11% off for certain dose rates.

This problem can be partially offset merely by using a higher dose rate, as would be the case if the magnify mode were employed. In a six inch mode, the required 7.2 mR/min dose rate will have less than 3% uncertainty due to noise and resolution.

Probe Saturation

All probes have a limit on the intensity of radiation they can measure. A common convention is to place the limit at the point where the probe's ion collection efficiency drops to 95% of its normal value. Usually this creates no confusion for the user because he understands the "dose rate limit" of the probe. When his meter readings approach that limit, he knows to change probes. However, in a pulse mode or integrate mode, the limits are not so apparent.

As an example, consider a 500 ml probe which can withstand a radiation pulse of 10 msec with an intensity of 5 R/Sec. This means that this probe will allow measurement (integrate mode) of a 10 msec pulse having a total dose of 0.05 R. The meter will display approximately 48 to 50 mR for such a pulse. A radiation pulse of this type can easily be encountered when performing half value measurements at high mA and small SID. A typical X-ray generator operating at 80 kV, 400 mA, 10 msec, will produce a pulse having an intensity of 10 R/sec at 50 cm SID. If such a pulse were measured in the integrate mode, we would expect to see a reading of 100 mR (0.01 sec x 10 R/sec). But the intensity of 10 R/sec far exceeds the capability of the 500 ml probe, and it will saturate. The ion collection efficiency will drop drastically, and the meter reading can be 30% or more in error. Small probes can withstand higher radiation levels in a pulse mode than large probes can. A 5 ml probe will withstand approximately 100 times the intensity level that a 500 ml probe can handle.

Meter Response to Pulse Train

The ability of a meter to respond to a repetitive radiation pulse, as encountered in a cine mode, is a function of design. The best method of determining if a meter's response is correct, is simply to check for linearity of response as pulse width and/or repetition rate are changed.

A typical check would be to operate at 60 frames per second and at 2 msec pulse width. Check the radiation dose rate. Then verify that the dose rate increases proportionately at 90 frames per second or at 3 msec pulse width.

Pulse widths below 2 msec in a cine mode should be avoided because the kV is in a transition period at the beginning of the pulse, and short pulses may not have well defined kV levels.

Rate measurements of photospot exposures are not recommended. Use the integrate mode instead.

Handling

Many radiation meters employ electrometers operating with current levels of 10^{-14} amps, and are very sensitive to condensation. Radiation meters, cables and probes should be kept in airtight plastic bags. Cold meters and probes should not be exposed to room air, because moisture may condense on a cold meter or on the cable ends. Allow meters and probes to come up to room temperature before opening the bags. Meters that have been wet by condensation should be allowed to dry for several hours, preferably while turned on.

APPENDIX B
FEATURES OF MINI CARDIOVASCULAR PHANTOM (7" ONLY)

B-1 DASI FEATURE OF MINI CARDIOVASCULAR PHANTOM (7" PHANTOM ONLY)

The term DASI stands for "Device to Align Source to Image", and refers to a device consisting of a narrow metal tube mounted in a plastic support. The device permits the user to locate, within an x-ray beam, that ray which is perpendicular to the surface of the DASI and strikes the center of the tube. This ray is usually (but incorrectly) referred to as central ray. Central ray is defined as that ray which is perpendicular to the anode-cathode axis of the tube. Since the reference surface for the DASI is the tube port plate or the table top, and since neither of these may be parallel to the anode-cathode axis of the tube, then the ray defined by the DASI is not necessarily the "central ray", but merely a ray perpendicular to the tube port plate or table top. In practice, the construction of General Electric tube casings is such that the ray defined by a DASI referenced to the tube port plate is very close to central ray.

The DASI incorporated in the Mini Cardiovascular Phantom is not intended to be used as an installation tool. A precision DASI (DASI-Type II) is supplied for installation purposes. The DASI in the Mini Cardiovascular Phantom can be used to detect changes in alignment which might be the result of some mechanical defect in the system such as loosening of the tube mounting.

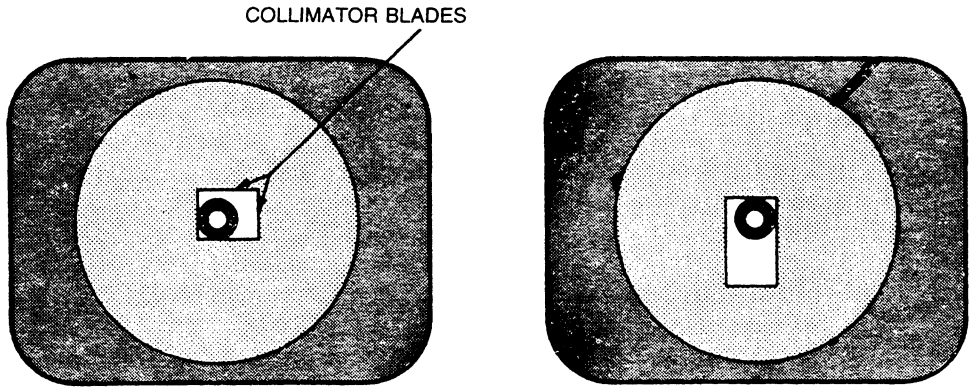
Procedure (Vascular Only)

1. Place the Mini Cardiovascular Phantom on the 1/4 inch aluminum filter and leveling table.
2. Place the Phantom in the approximate center of the x-ray beam. Adjust the leveling feet so that the bubble level on the Phantom indicates true.
3. Operate the system at 60 kV and the highest magnification. The image intensifier entrance plane should be about 12 inches above the table.

4. Collimate to a small square. Align the Phantom so that the image of the tube is perfectly symmetrical. On curved table tops, be sure to move only the Phantom and not the leveling table. Recheck the bubble and realign, if necessary.

5. Switch to the 9 inch field and open the collimator wide. Equal numbers of alignment dots visible on opposite sides of the tube indicate good alignment of central ray to image intensifier center. The number of dots on one side of the tube may deviate from the number of dots on the opposite side by no more than one dot.

6. Collimate to the smallest square or rectangle possible without covering any part of the image of the tube. See Illustration B-1. Any empty space alongside the image of the tube must be narrower than the image of the tube. If the system passes this test, the central ray is aligned to the center of the collimator to within 1/8 inch.



ACCEPTABLE
Blank area to the right of tube image is narrower than tube image.

NOT ACCEPTABLE
Blank area beneath tube image is larger than tube image.

30154-D10

ILLUSTRATION B-1

B-2 FIELD SIZE TEST FEATURE OF THE MINI CARDIOVASCULAR PHANTOM (7" PHANTOM ONLY)

The alignment dots on the Phantom are spaced 0.32 inches apart. (See Illustration B-2.) Any four dots define a line exactly one inch long. The spacing is such that if the intensifier is lowered until nine dots are visible on each side of the tube in the 9 inch mode, then six dots will appear when the system is placed in the 6 inch mode. Four dots with a half space will appear in the 4-1/2 inch mode.

To check for correct ratio between the three field sizes, proceed as follows:

Procedure

1. Center the Phantom in the field in the nine inch mode. Lower the intensifier as far as possible. Collimate to a 1/2 inch wide strip.
2. Note the positions of the third and fourth dots from center. Mark these positions on the face of the CRT. See Illustration B-3.
3. Switch to the 6 inch mode. The inner marks should now coincide with the second dots from center.
4. Switch to the 4-1/2 inch mode. The outer marks should now coincide with the second dots from center.

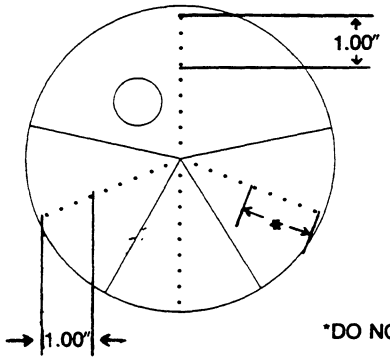


ILLUSTRATION B-2

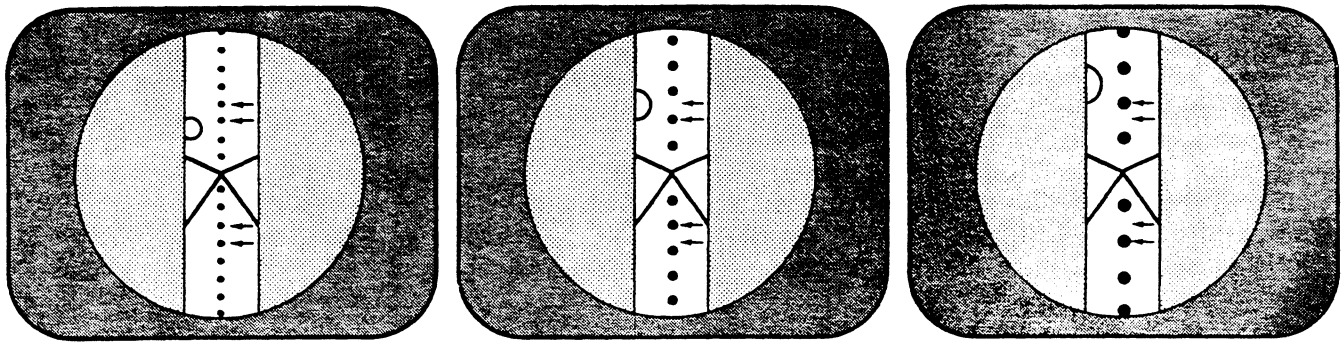


ILLUSTRATION B-3

APPENDIX C
BRIEF GLOSSARY OF X-RAY FILM TERMINOLOGY

Spectral Sensitivity The areas of the EMR spectrum to which a film is sensitive. Silver bromide films are all sensitive to ultraviolet and blue light as well as X-rays. Screen-type medical X-ray films are designed to be particularly sensitive to blue light and ultraviolet radiation from fluorescent screens, but some X-ray films are designed to be used without screens and are particularly sensitive to direct exposure from X-rays.

Speed (Sensitivity) The measure of a film's response to radiation. The faster films require less radiation (or exposure) to produce a radiograph of a given blackness. Usually films are rated with speeds relative to one another.

Density (Photographic) A measure of the blackness of an exposed and processed radiograph. The blackness is due to filamentary silver which absorbs some of the light when the radiograph is viewed on a view box. Mathematically $D = \text{Log}(1/T)$ (where T is the proportion of the light from the illuminator transmitted by the processed film).

Radiographic Contrast Radiographic contrast between two areas of a radiograph is the difference between the densities of those areas. The greater the difference, the greater the radiographic contrast. Radiographic contrast is affected by two groups of factors: subject contrast and film contrast.

Subject Contrast Subject contrast is the ratio of X-ray intensities transmitted by selected portions of the subject. It is affected by subject thickness, specific gravity, atomic composition, radiation quality, and scattered radiation. The radiographic contrast is governed by both subject contrast and film contrast.

Film Contrast Film contrast is denoted by the steepness, or slope, of the characteristic curve of the film – the steeper the slope, the higher the contrast. It is controlled by the type of film, the processing it receives, type of exposure (screen light or direct X-ray), density level exposed for, and fog. The radiographic contrast is affected by both film contrast and subject contrast.

Average Gradient (of a film) The steepness of the characteristic curve of a film. Usually measured as average gradient between two levels of density; e.g., the average gradient between a density of 0.25 and a density of 2.0 is the slope of a straight line connecting these points. Most X-ray films have a gradient of 2.5 to 4.0, and any film with a gradient over 1.0 amplifies the subject contrast.

Film Latitude Latitude refers to the exposure range within which a satisfactory radiograph is produced. Films which have the widest latitude are those which have the lowest film gradient and therefore the lowest film contrast.

Fog The density on a radiograph in an area of no deliberate exposure. It is a combination of base density, emulsion fog, and the effects of inadvertent exposure; e.g., defective safelights.

Gross Fog	The combination of base density and emulsion fog.
Base Density	The slight density which is due only to the film base and the blue dye in it. It is measured with the emulsion layer removed, or on a film which has been fixed without prior development.
Emulsion Fog	The slight density in an unexposed area of the film due to a small number of silver bromide crystals developing spontaneously. Film speed and improper processing or storage will affect emulsion fog. Safelight, white light, or radiation fog are not considered part of emulsion fog.
Screen Mottle (fluorescent screen exposures)	The visual impression of irregularity of density, in areas where the exposure is macroscopically uniform, due to the random spatial distribution of X-ray quanta absorbed in the screens. Screen mottle is much larger in scale and "softer" in outline than film graininess (see below).
Film Graininess (direct X-ray exposures)	The visual impression of irregularity of density, in areas where exposure is macroscopically uniform, due to the random spatial distribution of X-ray quanta absorbed in the film. In general, fast films exhibit greater graininess than slow films.
Definition	The distinctness or sharpness of detail in a radiograph. Definition is affected by geometric factors (focal spot size, F.F.D., object-film distance), and film factors (film graininess, contrast, exposure), as well as radiation factors (kilovoltage, screen mottle, screen contact, and scatter).
Radiographic Sensitivity	A general or quantitative term referring to the size of the smallest detail that can be seen in a radiograph, or to the ease with which the images of small details can be detected. Phrased differently, it is a reference to the amount of information contained in the radiograph.

REFERENCES

The Fundamentals of Radiography, Eleventh Edition, Eastman Kodak Company, 1968.

Physical and Photographic Principles of Medical Radiography, by Herman E. Seemann; John Wiley & Sons, Inc., New York, 1968.

Radiographic in Modern Industry, Second Edition, Eastman Kodak Company, 1957.

Fundamentals of Photographic Theory, Second Edition, by T.H. James and G.C. Higgins; Morgan & Morgan, New York, 1960.

The Theory of the Photographic Process, Third Edition, T.H. James, Editor; MacMillan Company, 1966.

APPENDIX D
EFFECTS OF FILM DEVELOPMENT TIME AND DEVELOPER TEMPERATURE

Effect of Film Development Time

Both the speed and the contrast of a film increases as the development time increases, within certain limits. The graph below shows the characteristic curves of a typical film developed for a series of times at a set temperature. It can be seen that as development time increases, the characteristic curve grows progressively steeper and the speed increases. Generally, at the recommended development time, the maximum contrast (average gradient) is achieved without a rise in base fog. If development time increases above this point, it results in a loss of contrast and very little gain in speed.

Effect of Developer Temperature

By maintaining the same development time and increasing the development temperature, the same results occur as in the increase of developer time. Each film has a range of development times and temperatures which yield reasonable results. It is our task and that of the film manufacture to find the specific curve which yields the best results on a given system.

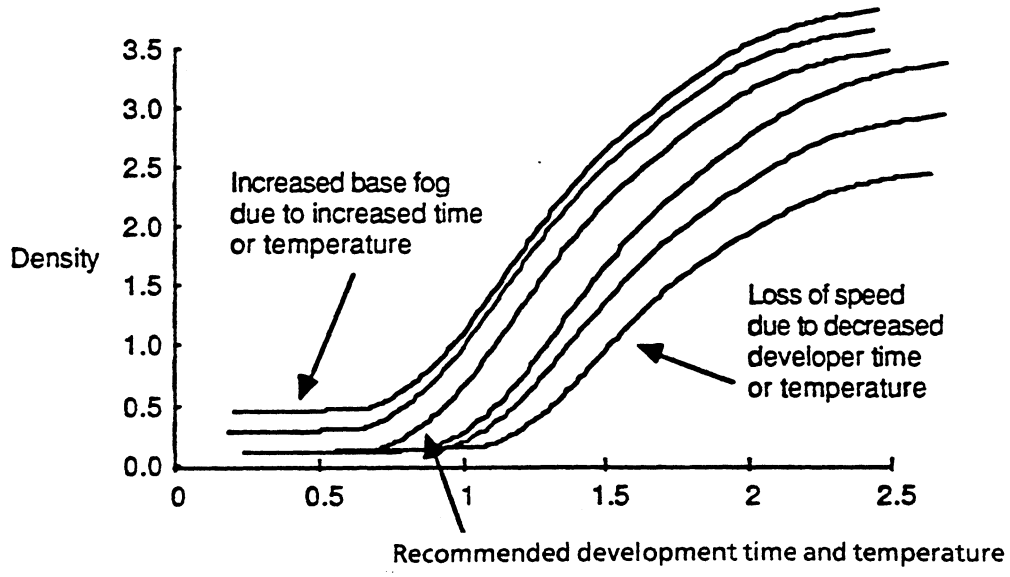


ILLUSTRATION D-1
RECOMMENDED DEVELOPMENT TIME AND TEMPERATURE

APPENDIX E
TYPICAL CINE FILM CHARACTERISTICS

ILLUSTRATION E-1 KODAK CFC

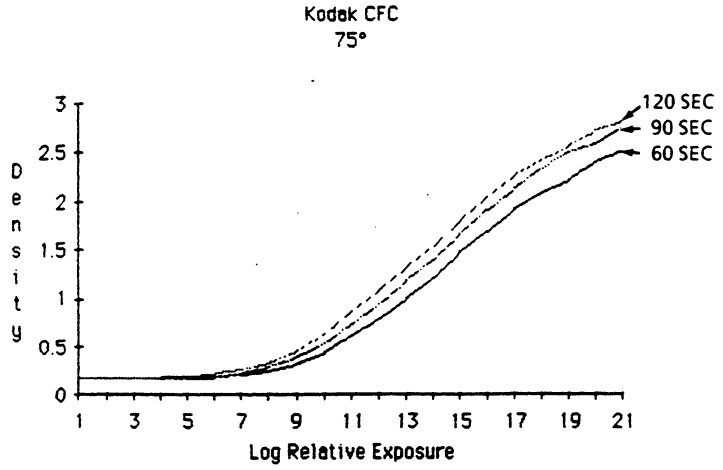
ILLUSTRATION E-2 KODAK CFR

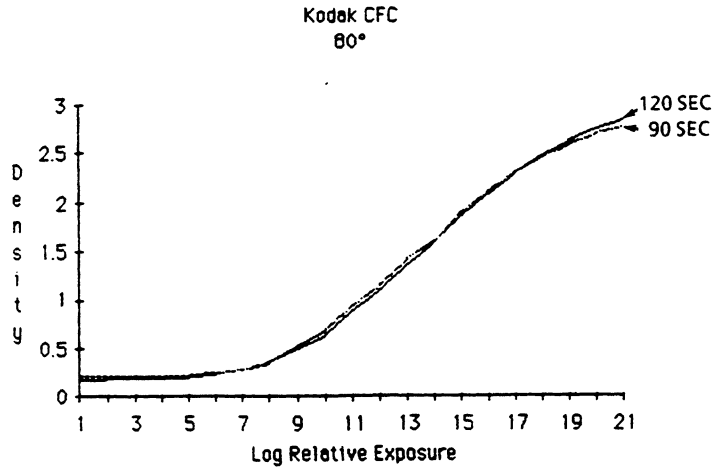
ILLUSTRATION E-3 KODAK CFS

ILLUSTRATION E-4 CINEGRAM F

ILLUSTRATION E-5 CINEGRAM PF

ILLUSTRATION E-6 VARICATH ADCV3





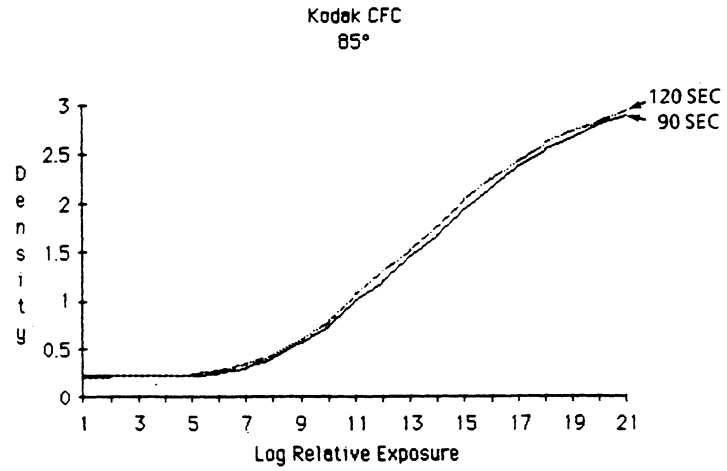
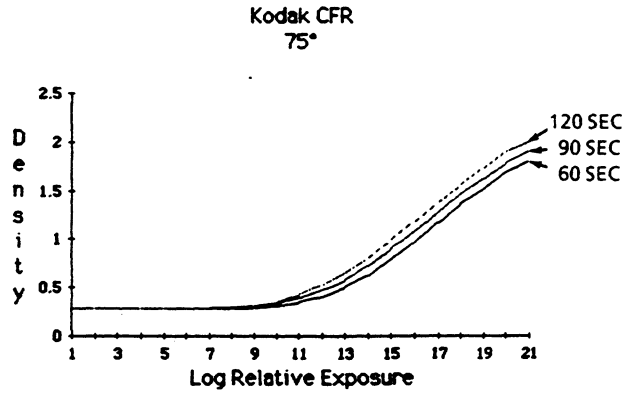
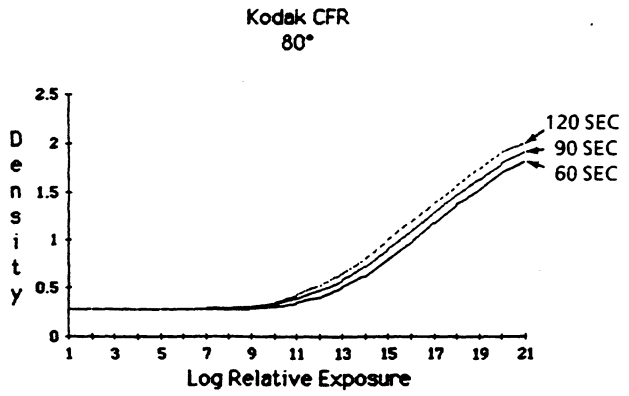
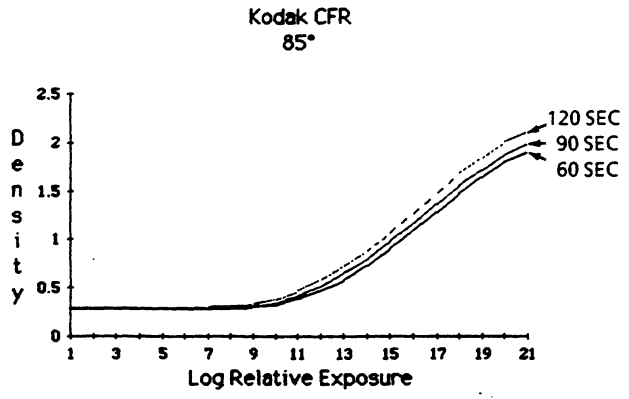
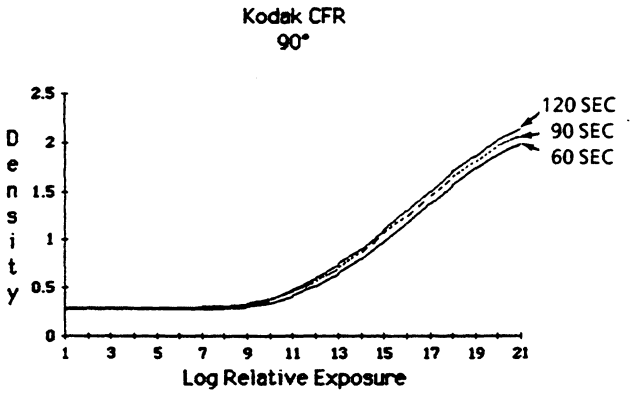


ILLUSTRATION E-1
KODAK CFC









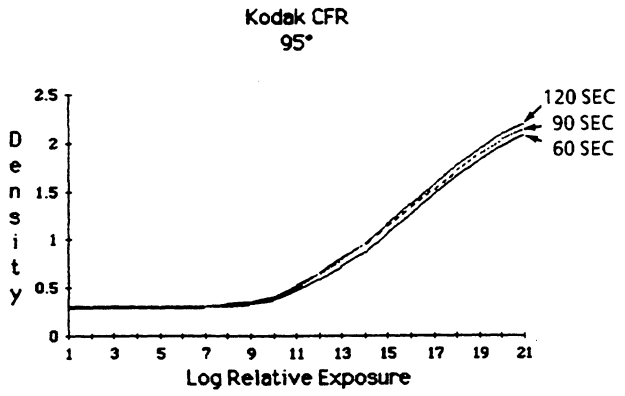
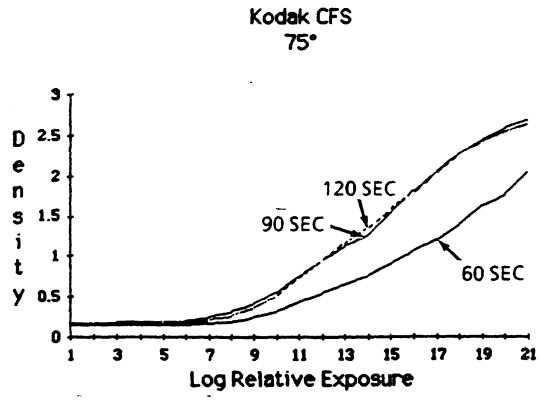
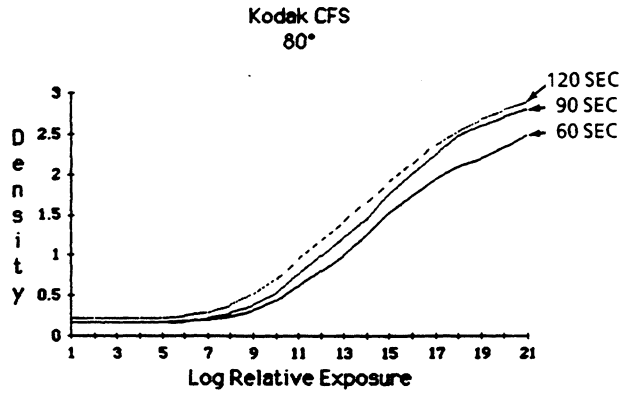
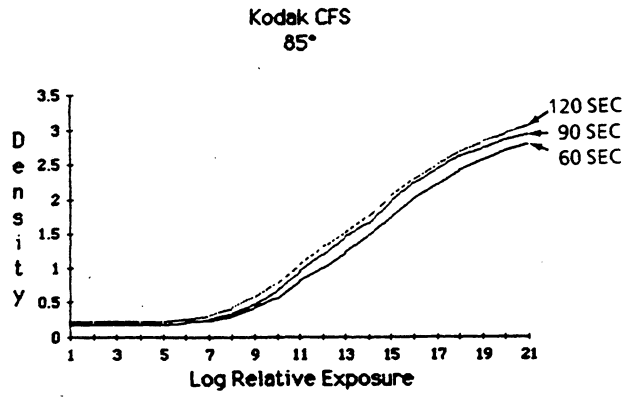
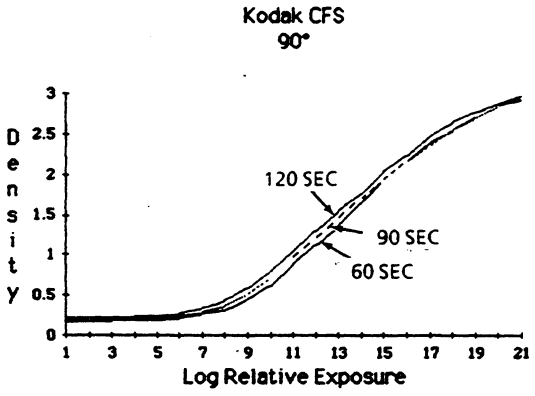


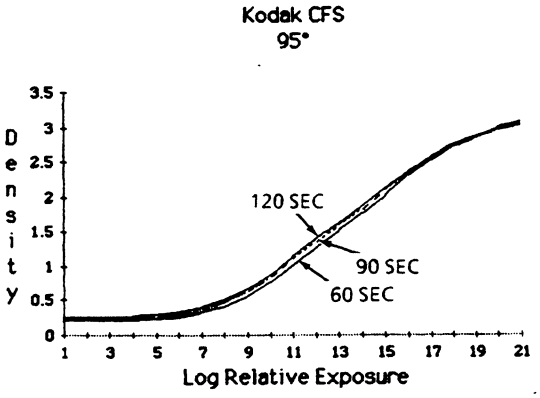
ILLUSTRATION E-2
KODAK CFR











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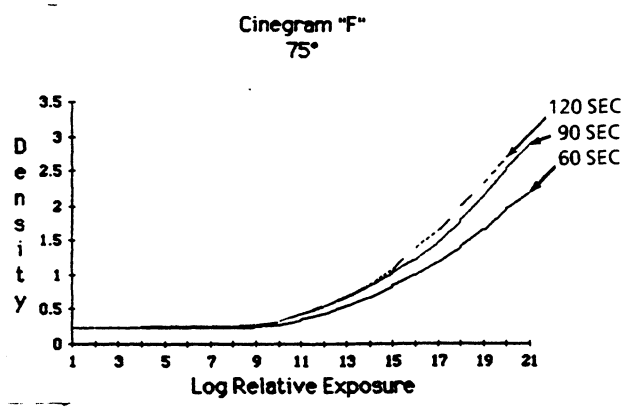
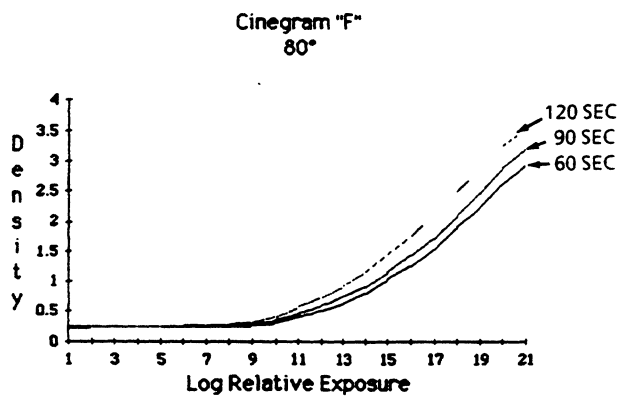
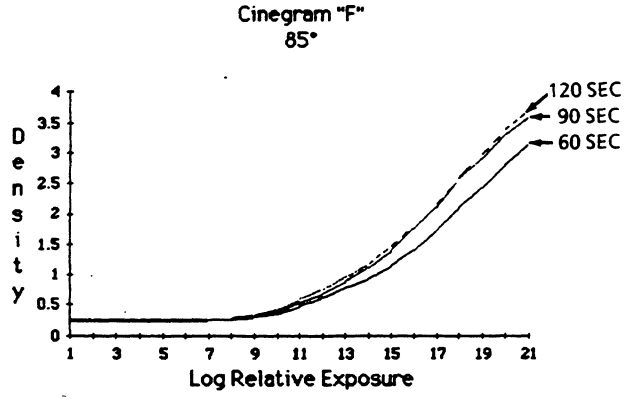
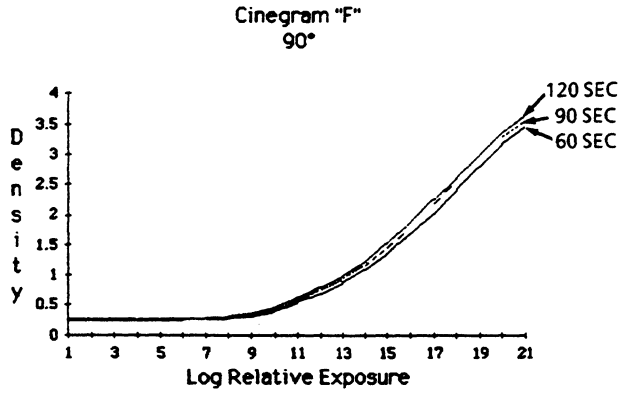








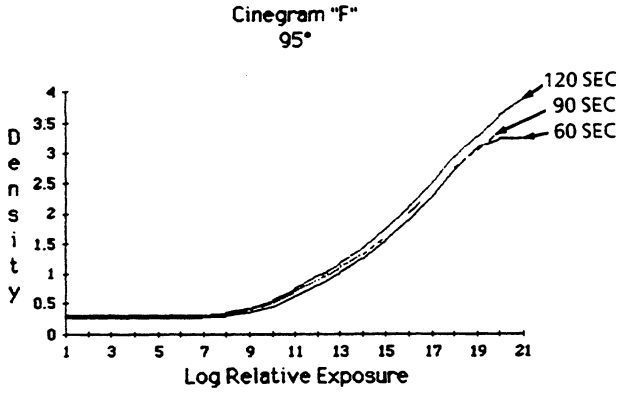
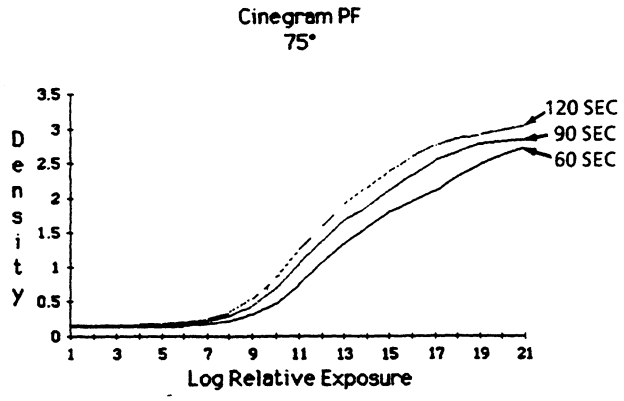
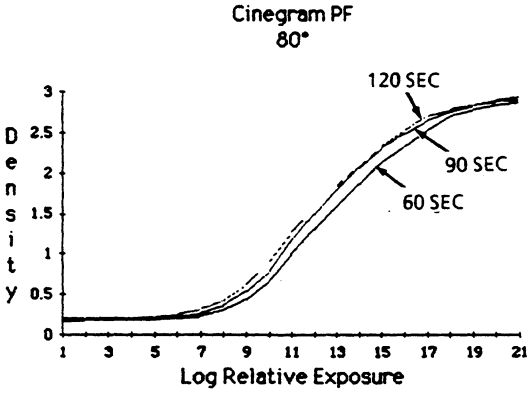
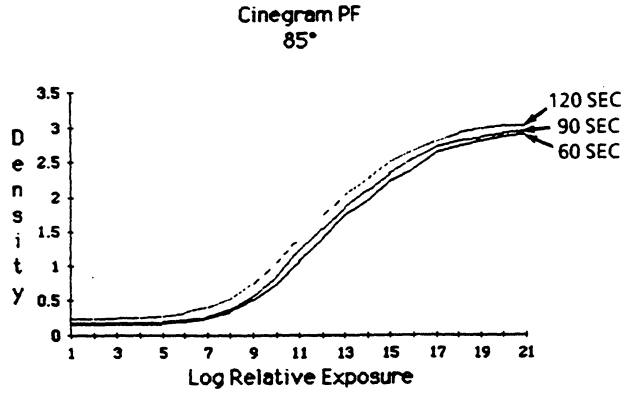
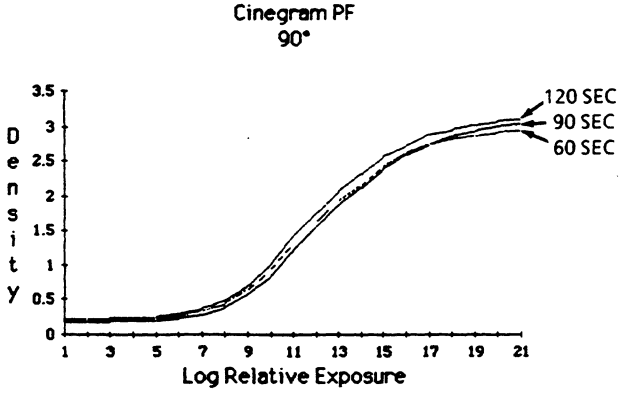


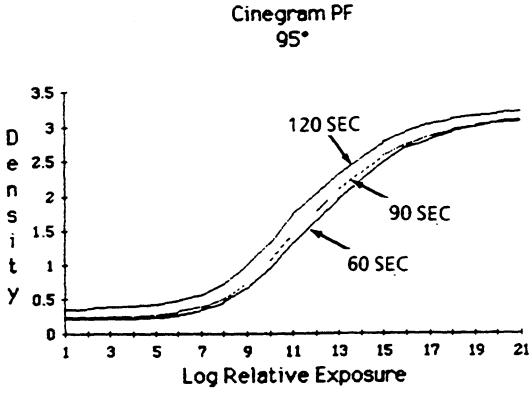
ILLUSTRATION E-4
CINEGRAM F











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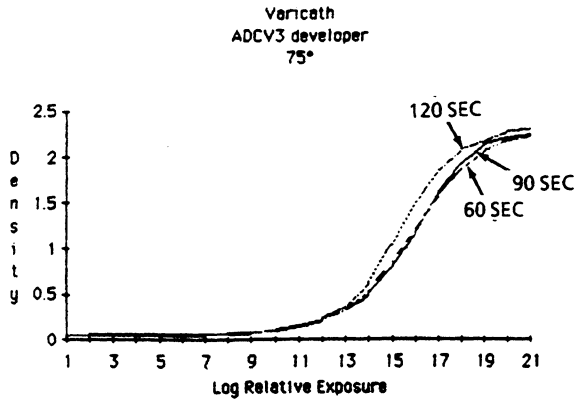
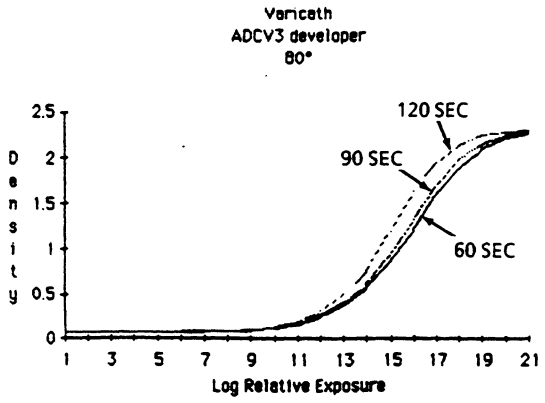
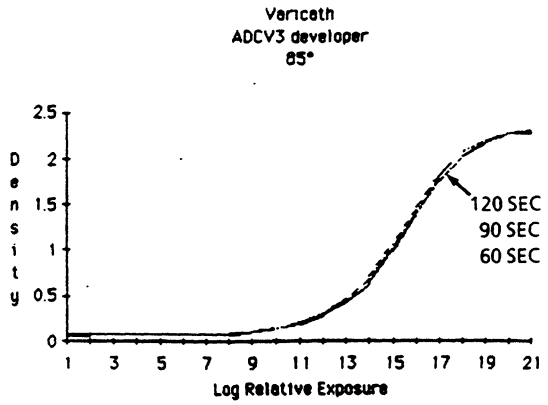
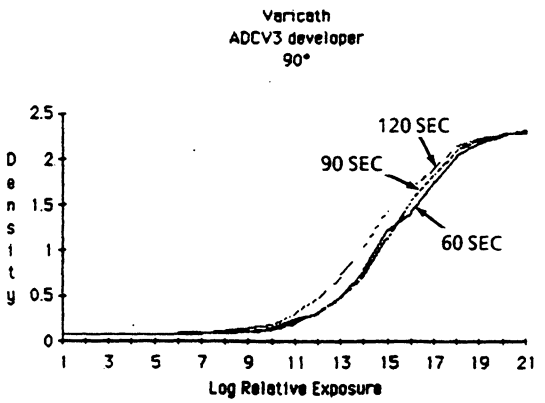
CINEGRAM PF









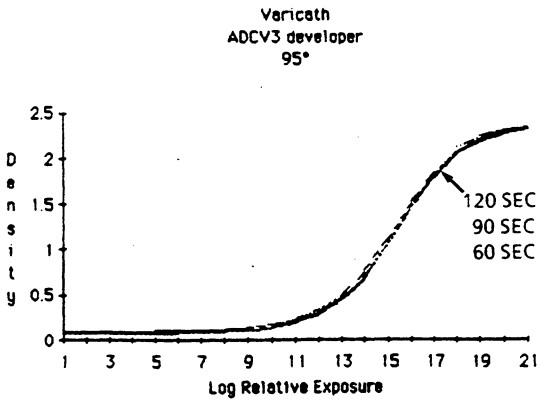


ILLUSTRATION E-6
VARICATH ADCV3

APPENDIX F
CINE FILM TROUBLESHOOTING GUIDE

Problem		Reason	Corrective Action
Image density too high	Over-developing	Developing temperature too high	Adjust developing temperature • Check thermostat • Check temperature of washing water
		Developing time too long	• Check developing speed
		Excessive replenishment	Adjust replenishment rate • Check replenishment system
		Faulty mixing of developer	Replace with fresh solution
Image density too low	Under developing	Developing temperature too low	Adjust developing temperature • Check developer heater • Check thermostat • Check temperature of washing water
		Developing time too short	• Check developing speed
		Exhaustion of developer, or contaminated with fixer	Replace with fresh solution
		Replenisher deficient	Increase replenishment rate
		Excessive starter	Replace with fresh replenisher •Reconfirm the amount of starter
		Insufficient agitation	Check circulation system
		Developer diluted	Replace with fresh solution

Problem		Reason	Corrective Action
Contrast too high	Over-developing	Developing temperature too high	Adjust developing temperature •Check thermostat •Check temperature of washing water •Check cooling water
		Developing time too long	Adjust developing time
		Excessive replenishment	Adjust replenishment rate
	Film contrast too high		Use suitable film
	Developer contrast too high		Use suitable developer
Contrast too low	Under-developing	Developing temperature too low	Adjust developing temperature •Check developer heater •Check thermostat •Check temperature of washing water
		Developing time too short	Adjust developing time
		Exhaustion of developer	Replace with fresh solution
		Wrong replenishment rate	Adjust replenishment rate
		Insufficient agitation	Check circulation system (circulation motor, filter)
	Exhaustion of developer	Contaminated with fixer	Replace with fresh solution

Problem		Reason	Corrective Action
Fog	Exposure to chemicals or vapor	Formalin, hydrogen sulfide, painted surface, acetylene, thinner, hydrogen peroxide, terpene, engine exhaust, mercury vapor, etc.	Choose appropriate storing places
	Storage at high temperature		Same as above
	Storage under high humidity		Same as above
	Expiration date overdue		Replace with fresh film
	Exposure to light	Light leak	Check darkroom ●Check cover of processor
	Exposure to safelight		Turn off safelight
	Exposed to X-rays		Prevent exposure ●Do not store films in X-ray room
	Pressure fogging		Do not apply pressure on film ●Check roller surface
	Faulty developer	Formula incorrect	Use correct formula
		Excessive dilution	Maintain correct concentration
		Deficient dilution	Same as above
		Faulty chemicals	Replace chemicals
		Incorrect measurement	Repeat measurement
		Contaminated with fixer	Replace with fresh solution
		Used immediately after preparation	Leave prepared solution for one day before use
	Water quality poor	Presence of iron and copper ion	Prevent contamination
	Developer oxided	Air fogging	Replace with fresh solution

Problem		Reason	Corrective Action
Streaks	Insufficient agitation	Developer	Agitate solution sufficiently
		Fixer	Same as above
	Developing time too short		Develop correctly
	Uneven drying		Adjust dryer air squeege
		Drying temperature too high	Check temperature setting
Yellow or brown stain	Stain by developer	Developer exhausted	Replace with fresh solution
		Neutralization in fixer too slow	Increase agitation
	Yellow coloration on whole surface by fixing	Insufficient fixing due to decomposition of hypo	Replace with fresh solution Fix sufficiently
	Silver or silver sulfide stuck	Fixer exhausted	Replace with fresh solution Wash rollers
		Developer exhausted	Same as above

APPENDIX G
MEDICAL TERMS* AND DIAGRAMS OF THE HEART

A

Akinesia (ah" ki - ne' ze - ah)

1. Absence or loss of the power of voluntary motion.
2. Immobility.
3. The postsystolic interval of rest of the heart.

Aneurysm (an' u - rizm)

Circumscribed dilation of an artery, or a blood-containing tumor connecting directly with the lumen of an artery.

Angina (an - ji' nah)

1. Sore throat from any cause.
2. A severe constricting pain.

Angina Pectoris

Breast pang; heart stroke; stenocardia; coronarism; Elsner's asthma; Neberden' asthma; cardiagra; severe constricting pain in the chest, often radiating from the precordium to the left shoulder and down the arm, due to ischemia of the heart muscle, usually caused by coronary disease.

Arrhythmia (ah - rith' me - ah)

Irregularity; loss of rhythm; denoting especially an irregularity of the heart beat.

Atherosclerosis (ath' er - o" skle - ro' sis)

Nodular sclerosis; arteriosclerosis characterized by lipid deposits in the intima, irregularly distributed in large and medium sized arteries. The lipid deposits are associated with fibrosis and calcification, and are almost always present to some degree in the middle-aged and elderly.

Artrial Septal Defect (ASD) (a' tre - al)

A hole in the septum between the right and left atria of the heart. (Congenital).

*A single ' indicates the most strongly accented syllable.

B

Bradycardia (**brad" e - kar' de - ah**) Slowness of the heartbeat, usually defined as a rate under 60 beats per minute.

C

Cardiomegaly (**kar" de - o - meg' ah - le**) Enlargement of the heart.

Cardiomyopathy (**kar" de - o - mi - op' ah - the**) Disease of the myocardium.

Cardiopericarditis (**kar" de - o - per" i - kar - di' tis**) Inflammation of both myocardium and pericardium.

Cardioversion (**kar' de - o - ver" zhun**) Restoring the heart's rhythm to normal by means of electrical countershock.

Collateral

1. Indirect, subsidiary or accessory to the main thing; side by side.
2. A side branch to a nerve akon or blood vessel.

Cordis Of the heart.

Cyanosis (**si" ah - no' sis**) A dark bluish or purplish coloration of the skin and mucous membrane due to deficient oxygenation of the blood.

D

Diastole (**di - as' to - le**) The dilation of the heart cavities, during which they fill with blood; diastole of the atria precedes that of the ventricles; diastole alternates rhythmically with systole or contraction the the heart musculature.

Ductus Arteriosus (**duk' tus ar - te' re - us**) Bottallo's duct; arterial canal or duct; a fetal vessel connecting the left pulmonary artery with the descending pulmonary artery with the descending aorta. During the first two months after birth, it normally becomes changed into a fibrous cord, the ligamentum arteriosum. Its occasional failure to close postnatally causes a definite cardiovascular handicap that can be dealt with surgically.

Dyskinesia (**dis" ki - me' ze - ah**) Difficulty in performing voluntary movements.

E

Ectopic (ek - top' ik) 1. Aberrant; heterotopic; out of place; said of an organ which is not in its proper position, or of a pregnancy occurring elsewhere than in the cavity of the uterus.

2. In cardiography, denoting a heartbeat that has its origin in some abnormal focus; arising from a focus other than the sinoatrial node.

Ectopic Rhythm Any cardiac rhythm arising from a center other than the normal pacemaker, the sinus node.

Embolism (em' bo - lizm) Obstruction or occlusion of a vessel by a transported clot or vegetation, a mass of bacteria, or other foreign material.

Endocarditis Inflammation of the endocardium, or lining membrane of the heart. It may involve only the membrane covering the valves (valvular endocarditis) or the general lining of the chambers of the heart (mural endocarditis).

Endocardium The innermost tunic of the heart, which includes endothelium and subendothelial connective tissue. In the atrial wall smooth muscle and numerous elastic fibers also occur.

Endothelium (en" do - the' le - um) A layer of flat cells lining especially blood and lymphatic vessels.

Epicardium The visceral layer of the pericardium; the serous membrane that immediately envelopes the heart.

F

Fibrillar (fi' bri - lar) Relating to a fibril, or to fine rapid contractions or twitching of fibers or of small groups of fibers in skeletal or cardiac muscle.

Fibrillation, Atrial Ataxia cordis; delirium cordis; in which the normal rhythmical contractions of the cardiac atria are replaced by rapid irregular twitchings of the muscular wall; the ventricles respond irregularly to the dysrhythmic bombardment from the atrai.

Fibrillation, Ventricular Fine, rapid, fibrillary movements of the ventricular muscle that replace the normal contraction.

H

His Bundle (hiss) The bundle of modified cardiac muscle fibers that begins at the atrioventricular node and passes through the right artrioventricular anulus fibrosis to the membranous part of the interventricular septim; its right and left branches extend to the lower, muscular area of the septum and ramify in the subendocardium of the right and left ventricles.

Hyperplasia (hi" per - pla' ze - ah) An increase in number of cells in a tissue or organ, excluding tumor formation, whereby the bulk of the part or organ is increased.

Hypertrophy (hi - per' tro - fe) Overgrowth; general increase in bulk of a part or organ, not due to tumor formation.

I

Idiopathic Hypertrophic Subaortic Stenosis (IHSS) Left ventricular outflow obstruction due to hypertrophy of the ventricular septum; of unknown cause.

Infarction (in - fark' shun) Local arrest or sudden insufficiency of arterial or venous blood supply due to emboli, thrombi, vascular torsion, or pressure that produces a macroscopic area of necrosis; the heart, brain, spleen, kidney, intestine, lung, and testes are most affected, as are tumors, especially of the ovary or uterus.

Ischemia (is - ke' me - ah) Hypoemia; local anemia due to mechanical obstruction to the blood supply.

L

Lesion A wound or injury. A more or less circumscribed pathologic change in the tissues. One of the individual points or patches of a multifocal disease.

Lumen

1. The space in the interior of a tubular structure, such as an artery or the intestine.
2. The unit of luminous flux; the luminous flux emitted in a solid angle of 1 steradian by a uniform point source of light having a luminous intensity of 1 candela.

M

Mediastinum (me" de - as - ti' num) — The mass of tissues and organs separating the two lungs.

Mitral Valve (Valva Artrioventricularis Simstra) (mi' tral) — The valve closing the orifice between the left atrium and left ventricle of the heart; its two cusps are called anterior and posterior.

Mural — Relating to the wall of any cavity.

Myocardium (mi" o - kar' de - um) — The middle and thickest layer of the heart wall, composed of cardiac muscle.

N

Necrosis (ne - kro' sis) — The pathologic death of one or more cells, or of a portion of tissue or organ, resulting from irreversible damage.

O

Occlusion (o - kloo' zhun) — The act of closing, or the state of being closed.

Occlusion, Coronary — Blockage of a coronary vessel usually by thrombosis and usually leading to infarction of the myocardium.

P

Patent Ductus Arteriosus (PDS) — Open ductus arteriosus. A congenital heart disease caused by failure of the ductus arteriosus to close after birth.

Pericardium (per" i - kar' de - um) — The membrane around the heart. The fibroserous membrane, consisting of mesothelium and submesothelial connective tissue, covering the heart and beginning of the great vessels; it is a closed sac having two layers – that immediately surrounding the heart, the visceral layer, or epicardium, and the outer parietol layer, forming the sac, composed of strong fibrous tissue lined with serous membrane.

Precordia (pre - kor' de - ah) — The diaphragm; the entrails; before the heart. The epigastrium and anterior surface of the lower part; of the thorax.

Prolapse

1. To fall or sink down, said of an organ or other part.
2. A falling down of an organ or other part, especially its appearance at a natural or artificial orifice.

S

Sclerosis (skle - ro' sis) Induration or hardening of chronic inflammatory origin; especially induration of nervous and other structures by a hyperplasia of the interstitial fibrous or glial connective tissue.

Septum A thin wall dividing two cavities or masses of softer tissue.

Shunt
1. To change direction; to divert.
2. Diversion of accumulations of fluid to an absorbing or excreting system by fistulation or a mechanical device to establish a communication between the origin and the terminus.

Shunt, Atriovenous Derivitive circulation; the passage of blood directly from arteries to veins, without going through the capillary network.

Shunt, Left-To-Right A diversion of blood from the left side of the heart to the right (as through a septal defect), or from the systemic circulation to the pulmonary (as through a patent ductus arteriosus).

Shunt, Right-To-Left Reversed shunt; the passage of blood from the right side of the heart to the left (as through a septal defect), or from the pulmonary artery into the aorta (as through a patent ductus arteriosus); such a shunt can occur only when the pressure in the right heart exceeds that in the left, as in advanced pulmonic stenosis.

Sinoatrial (si" no - a' tre - al) Relating to the sinus venosus and the right atrium of the heart.

Sinus Rhythm Normal cardiac rhythm proceeding from the sinoatrial node.

Stenosis A narrowing of any canal; astricutre; especially the narrowing of one of the cardiac valves.

Stenosis, Aortic Pathologic narrowing of the aortic valve orifice.

Stenosis, Coronary Ostial Narrowing of the mouths of the coronary arteries, usually the result of syphilitic aortitis.

Systole (sis' to - le) The rhythmical contraction of the heart, especially of the ventricles, by which the blood is driven through the aorta and pulmonary artery to traverse the systemic and pulmonary circulations, respectively; its occurrence is indicated physically by the first sound of the heart on auscultation, by the palpable apex beat and by the arterial pulse.

T

Tachycardia (tak" e - kar' de - ah) — Rapid beating of the heart, usually applied to rates over 100 beats per minute.

Tachycardia, Atrial — Originating in an ectopic focus in the atrium.

Tachycardia, Ectopic — A tachycardia originating in a focus other than the sinus node, e.g., atrial, A-V nodal, or ventricular.

Tachycardia, Ventricular — Originating in an ectopic focus in the ventricle.

Tetralogy of Fallot — Fallot's tetrad; the most common form of cyanotic congenital heart disease, the tetralogy consisting of pulmonic stenosis, ventricular septal defect, dextroposition of the aorta, and right ventricular hypertrophy.

Thermodilution — Reduction in temperature in a liquid which occurs when it is introduced into a colder liquid. The volume of the latter liquid can be calculated from the amount of rise in its temperature.

Thrombus — A clot in a blood vessel or in one of the cavities of the heart, formed during life from consituents of blood; it may be occlusive or attached to the vessel or heart wall without obstructing the lumen.

Trabecula (trah - bek' u - lah) — One of the supporting bundles of fibers traversing the substance of a structure, usually derived from the capsule or one of the fibrous septa.

Trabecular Carneae — Muscular bundles on the lining walls of the ventricles of the heart.

Transposition of Great Vessels — Transposition of arterial stems; a cyanotic form of congenital cardiovascular malformation in which the aorta arises from the right ventricle while the pulmonary artery arises from the left ventricle; for life to exist there must be an associated septal defect or patent ductus arteriosus to permit some cross flow between the two circulations.

Tricuspid Valve (Valva Atrioventricularis Dextra) (tri - kus' pid) — The valve closing the orifice between the right atrium and right ventricle of the heart; its three cusps are called anterior, posterior, and septal.

V

Vas A vessel; a duct or canal conveying any liquid, such as blood, lymph, chyle, or semen.

Vascular Relating to or containing blood vessels.

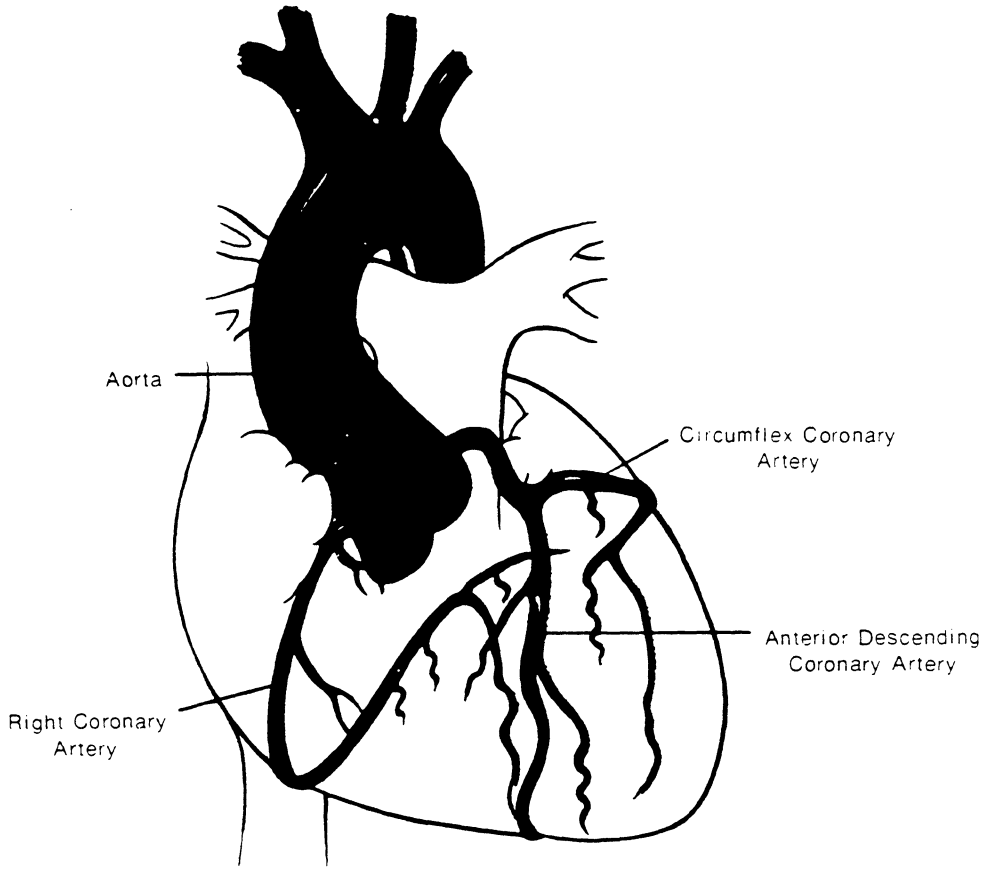
Vascularity The condition of being vascular.

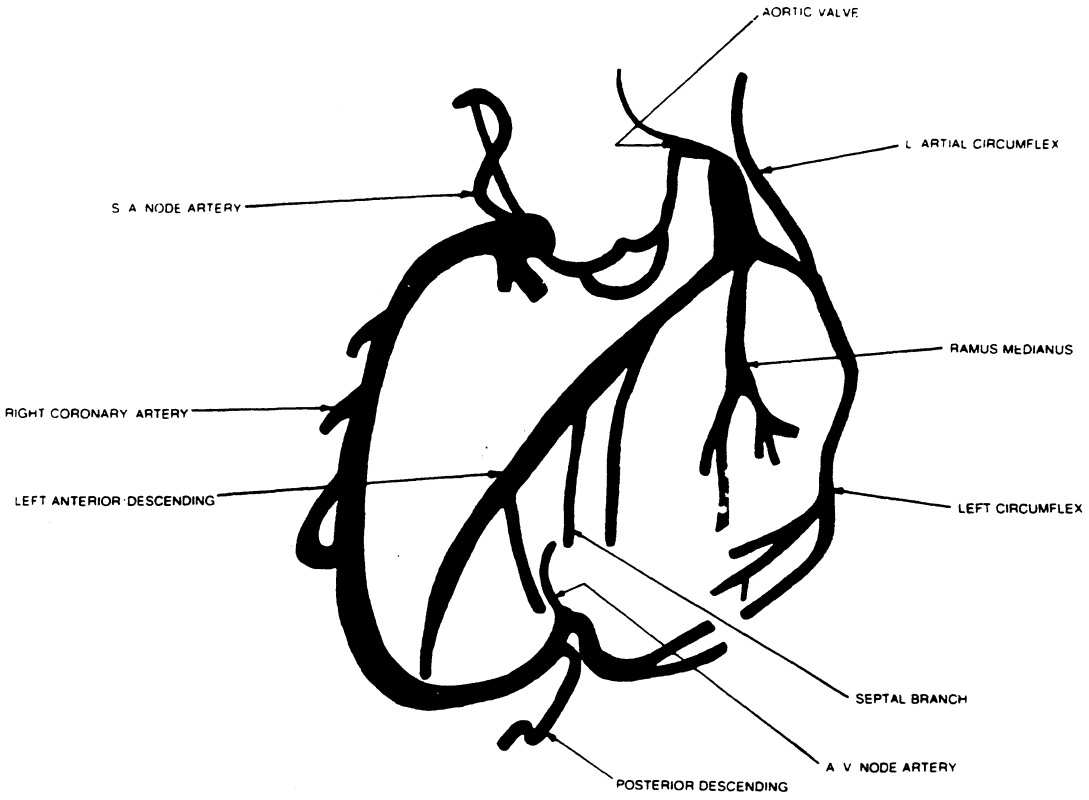
Vascularization The formation of new blood vessels in a part.

Vasculature The vascular network of an organ.

Ventricular Septal Defect (VSD)
(ven - trik' u - lar) A hole in the septum between the right and left ventricles of the heart. (Congenital).

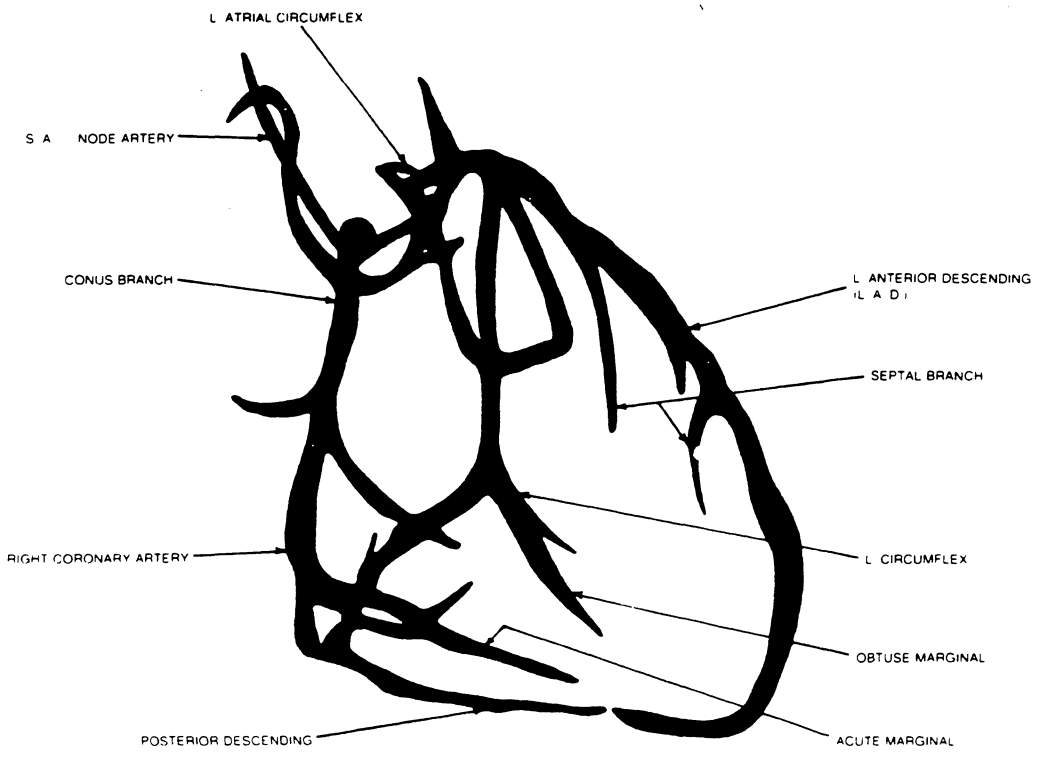
Valves of the Heart
Aortic v.
Mitral v.
Tricuspid v.
LV to Aorta
LA to LV
RA to RV





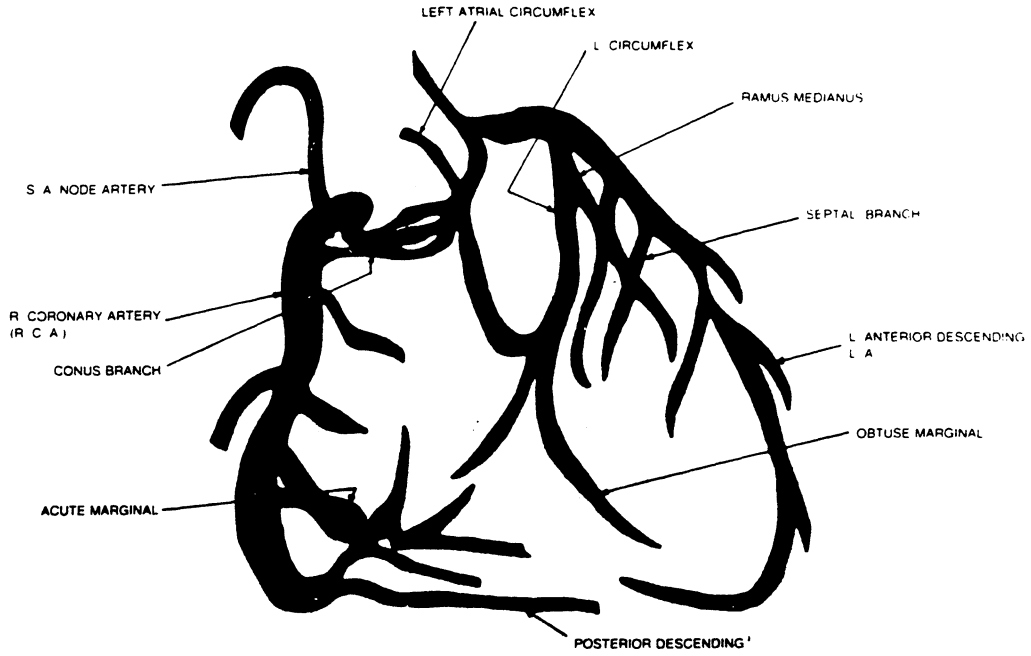
30666-D10

LEFT ANTERIOR OBLIQUE VIEW

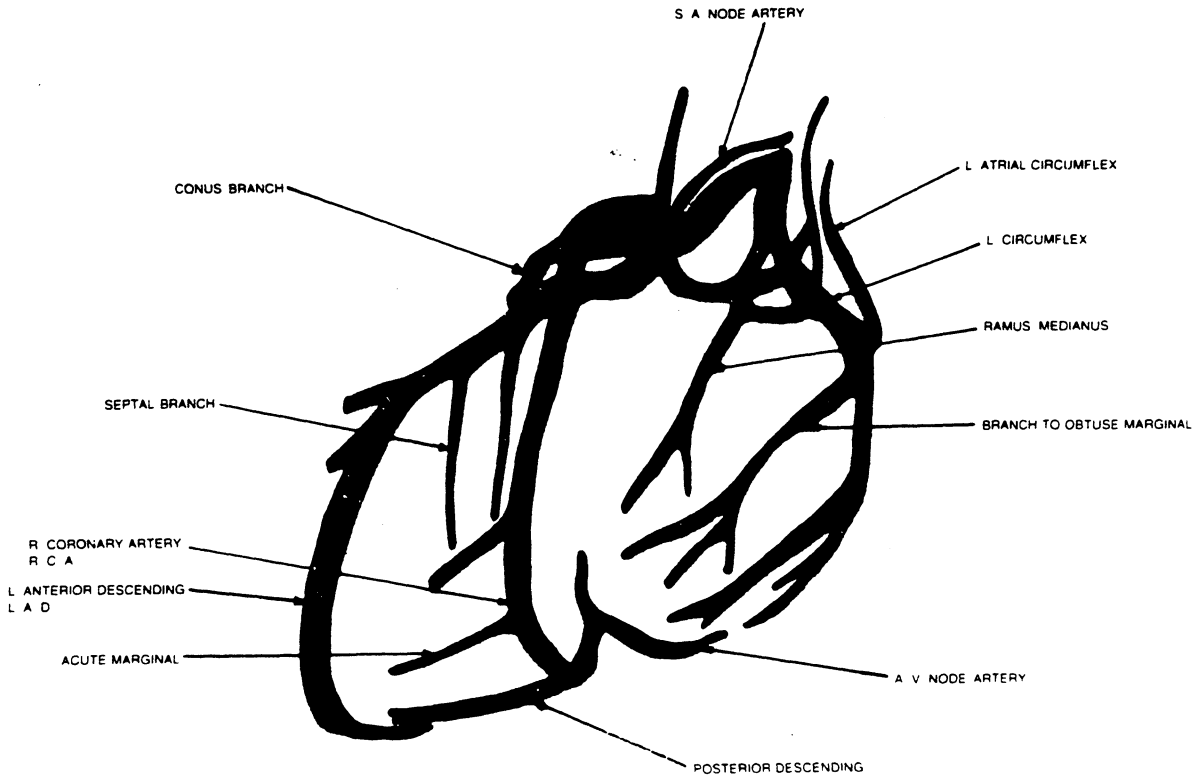


30667-D10

RIGHT ANTERIOR OBLIQUE VIEW



ANTERIOR-POSTERIOR VIEW 30668-D10



LATERAL OBLIQUE VIEW 30669-D10

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